

VI. THE FOSSILS OF THE FRANKSTOWN CAVE, BLAIR COUNTY, PENNSYLVANIA.

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(PLATES XVII-XXV.)

In April, 1907, the American Lime and Stone Company of Blair County, Pennsylvania, during their operations in their limestone quarry near Frankstown, blasted into a cave, which contained Pleistocene fossils. The distance from the historic hamlet of Frankstown on the Juniata River to the top of the hill, in which the above mentioned quarry is located, is approximately one quarter of a mile; hence the name "Frankstown Cave." Messrs. E. H. L. Page and H. H. Jack of Hollidaysburg, Pennsylvania, who had become interested in the discovery of fossil remains, telegraphed to the Director of the Carnegie Museum, asking to have the matter scientifically investigated. The writer was instructed by Dr. W. J. Holland, the Director, to look into the discovery with a view to the recovery of any fossil remains in the deposit. Arriving at the quarry it was found that the entire length, breadth, and in most places the height of the cave had already been exposed by the workmen, Mr. James King Henry in charge. The value of the find was soon determined and the return to Pittsburgh for tools and material for the undertaking of excavation in this newly discovered cave was quickly made. Mr. Henry, the Superintendent, and the men engaged in working at the quarry, did much to facilitate the recovery of that part of the collection which had not already found its way to the dump, or had been picked up and distributed by "curio-hunters" and thus permanently lost. The work continued from two to three weeks, during which time Dr. Holland spent two days with the writer, making observations and photographs.

In the Frankstown Cave, as is usual in all limestone caverns, the material was found much disturbed and mutilated by fallen blocks, large and small, which had dropped from the roof and sides of the cave. Articulated skeletons were not found, and only in rare cases were there articulated parts. From this fragmentary material

additional knowledge is, however, obtained of the Pleistocene fauna of the Eastern States. A considerable portion of a skeleton of a Pleistocene Musk-ox was found, and this is for the first time described. Interesting data were collected as to the large Pleistocene bear of North and South America (*Arctotherium*) as well as other material. The finds are discussed in order in this paper.

In August, 1907, Dr. W. J. Holland read a short paper on the fauna of this quarry before the International Zoölogical Congress held in Boston. This paper was later published in the Annals of the Carnegie Museum, Vol. IV, 1908, p. 228 *et seq.*, and is referred to in the text of the present publication.

On account of the general disturbance of the contents of the cave by the work which had already been done, when I reached the quarry, there was comparatively little that could be ascertained as to the age, or the duration of time of this crevice. It should be noted, however, that in the middle vertical body of the deposit there was found the greatest variety of genera, while towards the top there were found more remains of the American Mastodon than anything else. At the very top, in a small nook of undisturbed debris and with the roof-rock still in place, there were found a number of fragments of bones of the Mastodon immediately underneath a thin mass of stalagmite. Although *Megalonyx*, *Tapirus*, and *Mylohyus* were poorly represented, the fact that their remains were found indicates that this cave existed at least during one interglacial period, perhaps equivalent in time to a part of that during which the famous Port Kennedy Cave existed, and perhaps closing at or about the time of the disappearance of the American Mastodon and the appearance of the arctic fauna.

In this paper there is given a detailed study of the differences between the spectacled bear (*Tremarctos ornatus*) of South America and *Arctotherium* of the *Pleistocene* for the purpose of pointing out the generic distinctions between the two forms, as well as the ursines in general. That there are noteworthy differences between these bears is readily accepted, but in the case of *Tremarctos* and *Arctotherium* I should prefer to wait for still more complete material representing *Arctotherium* before definitely designating the generic distinctions between the Pleistocene and the present South American form. In the meanwhile I have accepted the different genera as I find them in the literature.

Through the kindness and help of the National Museum, Washington, D. C., and the American Museum of Natural History, New York City, I have received recent osteological material for study and comparison. Messrs. C. Frick and H. E. Anthony of the American Museum, New York, and C. W. Gilmore of the National Museum, Washington, D. C., assisted in comparing certain features of the cranium of the recent Musk-ox, and Alexander Wetmore of the National Museum identified certain remains of a Ruffed Grouse. The photographs reproduced in this paper were made by Mr. A. S. Coggeshall; the drawings were made by Mr. Sidney Prentice.

Class AMPHIBIA.

Order CAUDATA.

Family CRYPTOBRANCHIDÆ.

A single vertebra, No. 11,149, found among the remains at the Frankstown Cave, apparently pertains to the proximal series of the caudal region of a *Cryptobranchus*-like animal considerably smaller than the recent *Cryptobranchus alleghenensis* (Daudin) of mature age. The median portion of the centrum is constricted and entirely closed by bony structure, while the anterior and posterior faces are deeply concave to receive the notocordal cartilage. The neural arch and zygapophyses agree best with those of *Cryptobranchus alleghenensis*. The main body of the hæmal arch, on the other hand, is longer fore-and-aft, the canal less in diameter, and the hypapophysial process much less developed than in *Cryptobranchus alleghenensis*.



FIG. 1. Proximal caudal of *Cryptobranchus* (?), C. M. Cat. Vert. Foss., No. 11,149. 2.5 diam.

Family PLETHODONTIDÆ.

A few vertebræ and other fragments of the higher *Urodela* are found in the mixed lot of fossil remains from the Frankstown Cave. A number of these vertebræ, C. M. Cat. Vert. Foss., No. 11,150, have been compared with the vertebral column of *Plethodon cinereus* (the common salamander of terrestrial habits) and are found to agree

in having the opisthocœlous centra and the double facets for the attachments of the ribs upon the transverse process. Other minor characters are also found on comparison to be similar, but the vertebræ of the fossil specimens have prominent neural spines, which are lacking in *Plethodon*. One of this series of vertebræ, No. 11,150, has a complete hæmal arch on the ventral face of the centrum, and in this respect agrees with the caudal vertebra of a newt. In size the fossil remains agree with such genera as *Plethodon*, *Eurysea*, or *Desmognathus*, but the lack of material for comparison at this time prevents a more detailed study.

Order **SALIENTIA**.

SUBORDER *LINGUATA*.

Family **RANIDÆ**.

A number of vertebræ, limb-bones, and other fragments of frogs and toads are found in the general mass of the remains from the Frankstown Cave. The condition of the material and the lack of recent specimens for comparison prevents at this time a study in detail. Parts of fore and hind limbs, No. 11,133, of apparently one individual, represent the genus *Rana*. The specimen has been compared with the skeleton of a recent specimen of *Rana catesbiana* Shaw, in the Museum, labelled *Rana mugiens* Merr., with which it appears to agree, except the relatively longer tibia-fibula of the fossil specimen. The ilium of the fossil is of about the same length as in the recent specimen used for comparison, but has a rounded upper border instead of the sharp and knife-like shape of the upper border of the ilium in the recent bull-frog of North America.

Numerous isolated limb-bones which were found, are very small, and indicate that different species of the order found their way into this cave from time to time during the deposition of the debris.

Class **REPTILIA**.

Order **SQUAMATA**.

SUBORDER *Sauria*.

Family **SCINCIDÆ?**

***Eumeces anthracinus* (Baird) (?)**

Plestiodon anthracinus BAIRD, Journ. Acad. Nat. Sc. Phila., (3), I, 1849, p. 294.

Eumeces anthracinus STEJNEGER and BARBOUR, Check-list N. A. Amphib. and Rept., 1923, p. 74.

Two vertebræ, No. 11,311, and one fragment of a bony plate, No. 11,313, are provisionally referred to the family and genus indicated above. The fragment has minute pits indicating small scales. The vertebræ are depressed and have typical lacertilian centra, deeply concave anteriorly and correspondingly convex posteriorly, with a large neural canal and rather heavy transverse processes.



FIG. 2. Vertebra of a lizard (C. M. Cat. Vert. Foss., No. 11,311) 2.5 nat. size.

SUBORDER *SERPENTES*.

Family COLUBRIDÆ.

Thamnophis sirtalis (Linnæus).

Coluber sirtalis LINNÆUS, Syst. Nat., Ed. 10, I, 1738, p. 222.

Thamnophis sirtalis sirtalis STEJNEGER and BARBOUR, Check-list N. A. Amphib. & Rept., 1924, p. 116.

Some remains of *Thamnophis sirtalis* were found in the general mass of material in the Frankstown Cave. The right maxillary, No. 11,322, though smaller than an average sized garter-snake, is recognized by actual comparison with specimen No. 1754 in the osteological series of the Museum. A second specimen, No. 11,319, also fragments of jaws, represent a snake somewhat larger than No. 11,322, but perhaps of the same species.

Remains of larger snakes (? *Coluber constrictor* Linnæus) were also found. In all there are seven fragments of jaws and many vertebræ, indicating at least two varieties of snakes. The fragmentary condition of the remains prevents detailed study.

SUBCLASS SYNAPSIDÆ.

Order TESTUDINATA.

Family TESTUDINIDÆ.

Clemmys insculpta (LeConte) (?).

Testudo insculpta LECONTE, Ann. Lyc. Nat. Hist. New York, III, 1830, p. 112.

Among the remains found in the cave is a fragment of the plastron

of a small turtle (C. M. Cat. Vert. Foss., No. 11,065) which was about six to eight inches in length. The concentric striation on the under face of the scutes together with the size of the fragment are the only characters available for comparison, and induce me to provisionally place the remains with the species established by LeConte.

Class AVES.

Order GALLINÆ.

Family MELEAGRIDÆ.

Meleagris superba Cope. Pl. XVII, figs. 1-10.

Meleagris superba COPE, Trans. Am. Philos. Soc., (N. S.) XIV, 1871, pp. 238-240.

A number of limb-bones of an adult turkey, C. M. Cat. Vert. Foss., No. 11,053, were found in the general mixture of remains. That these bones all belong to the same individual is certain, since there is no duplicate material. The right and left femora and tarso-metatarsals are included in the material. A careful comparison with Professor Cope's description (*l. c.*) and with the illustrations of the material in Yale Museum representing *Meleagris* described by Dr. R. W. Shufeldt,¹ induces me to refer the present specimen to Cope's species. The only discrepancy appears to be the slightly shorter tarso-metatarsus of the specimen from the Frankstown Cave. It may well be that the bones illustrated by Shufeldt are not all of one individual, and that the tarso-metatarsus (Shufeldt, *l. c.*, pl. XI, fig. 74) is of a larger individual than the femur and other bones illustrated in the same publication. Whether or not *M. superba* Cope, should be accepted as a valid species cannot be determined from the material available.

Family TÉTRAONIDÆ.

Bonasa umbellus (Linnæus).²

Tetrao umbellus LINNÆUS, Syst. Nat., Ed. 12, I, 1766, p. 275.

Bonasa umbellus STEPHENS, Gen. Zoöl., XI, 1819, p. 300.

The posterior part of a cranium (C. M. Cat. Vert. Foss., No. 11,325) and a portion of a tibio-tarsus (No. 11,325) of a Ruffed Grouse were

¹ *Fossil Birds in the Marsh Collection of Yale University*, Yale University Press, New Haven, Conn., 1915, p. 66, Pls. XI, XII.

² Identified by Dr. Alexander Wetmore of the U. S. National Museum.

picked out of the general mass of remains found in the Frankstown Cave. These bones, together with the remains of the turkey mentioned above, are the only bones of birds found in the cave.

Class MAMMALIA.

Order EDENTATA.

Family MEGALONYCHIDÆ.

***Megalonyx sphenodon* Cope (?).**

Megalonyx sphenodon COPE, Proc. Am. Philos. Soc., XII, 1871-1872, p. 85.

No. 11,050, C. M. Cat. Vert. Foss., represents a number of lower cheek-teeth and the apices of the canine-molars of a small ground-sloth. These teeth may represent Cope's species *Megalonyx tortulus*, *Megalonyx sphenodon*, or may even represent a new species, smaller than either. The two canine-molars agree most nearly with Cope's description of *Megalonyx sphenodon*, except for the smaller size, the long diameter at the grinding surface being only 15 mm. and the short diameter 7 mm., while in *Megalonyx sphenodon* the long diameter at the grinding surface is 25 mm. This diameter of the specimen at the Carnegie Museum would soon increase to that of the type as the increase in size of the teeth is apparently regular from the apex towards the base. The inner bulge of the tooth is well marked and is nearer the anterior than posterior margin, as Cope observed in the type of *M. sphenodon*. The dentine layer is also very slightly thicker externally than internally, though perhaps not to the same degree

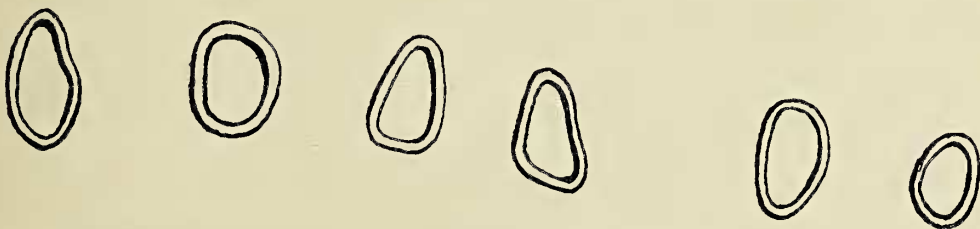


FIG. 3. Teeth of *Megalonyx sphenodon* Cope (?). C. M. Cat. Vert. Foss. No. 11,050. Nat. size.

as in the type of *M. sphenodon*. On cross-section the teeth back of the canine vary in outline from a triangle to an oval, and increase slightly in size from the apex to the base. The dentine layer is of even thickness externally and internally.

Order UNGULATA.

SUBORDER ARTIODACTYLA.

Family TAYASSUIDÆ.

Mylohyus pennsylvanicus (Leidy). Pl. XVIII, figs. 1-2.

Dicotyles pennsylvanicus LEIDY, Ann. Rept. Geo. Surv. of Penna. for 1887 (1889), p. 8, Pl. II, figs. 3-6.

Two or three individuals representing *Mylohyus* were found in the Frankstown Cave. No. 2330, C. M. Cat. Vert. Foss., is a pair of lower jaws very nearly complete, while No. 2330a consists of the greater part of both fore feet and portions of the hind feet, which may belong with the lower jaws, No. 2330. No. 11,047 consists of a few limb and foot-bones of a young individual.

The descriptions and illustrations of *Mylohyus pennsylvanicus* by Professors Leidy and Cope³ agree sufficiently closely with the remains from the Frankstown Cave to permit the reference of the latter to this species. The first permanent cheek-tooth, or P₂ of *M. pennsylvanicus* has not been described heretofore. Leidy's type was that of an immature individual and d.p.₂ appears to be broader posteriorly than the permanent tooth of the present specimen. However, the tooth of the specimen from the Frankstown Cave differs from p₂ in *Tayassu* in a somewhat similar manner as that of the type, and, as Leidy states (*l. c.* p. 9) the posterior tubercle, though of a simpler structure in the present specimen, is relatively larger than in the recent genus, while the median portion of the tooth is proportionally less developed. The anterior tubercle is extremely weak, and is perhaps to be more properly regarded as a heavy cingulum than as a tubercle. The succeeding cheek-teeth, as well as the canine and incisors, have been described from time to time by other writers.

As stated above, the fore and hind feet (No. 2330a) may belong with the lower jaw, No. 2330. The structure of the feet of the Frankstown specimen agrees quite closely with those found in the Conard Fissure of Arkansas, described by Mr. Barnum Brown in the Memoirs of the American Museum of Natural History, Vol. IX, 1908, p. 201, Plate XXIII.

³ Journ. Acad. Nat. Sci. Philad., Vol. XI, 1897-1901, p. 262.

Family CERVIDÆ.

SUBFAMILY CERVINÆ.

Odocoileus hemionus Rafinesque.

Odocoileus hemionus RAFINESQUE, Am. Monthl. Mag., I, 1817, p. 436.

Numbers 11,043 and 11,044 may possibly represent one individual. The material consists of fragments of the skull with the cheek dentition quite complete, and a number of limb and foot bones. The bones are those of an animal of considerably larger size than *Odocoileus virginianus* and most closely resemble the recent species, *O. hemionus*. The inner basal cusps of the molars, discovered in the Conard Fissure, which Mr. Brown found to be larger than in recent species examined,⁴ are in the present specimen small and rather irregularly developed, more nearly like the recent mule-deer. The limb and foot bones associated with the cranial remains described above are of appropriate size and most probably belong to the same individual.

Odocoileus virginianus (Boddaert) (?).

Cervus virginianus BODDAERT, Elench. Anim., I, 1785, p. 136.

At least two individuals (Nos. 11,045, 11,046) representing deer, about the size of that from the Port Kennedy Bone Deposit, described by Professor Cope as *Cariacus lævicornis*, are found in the material from the Frankstown Cave. Unfortunately there are no teeth associated with the limb bones, so that a close comparison cannot be made with Cope's species or with the remains of deer from the Conard Fissure of Arkansas described more recently by Mr. Barnum Brown.⁵ The remains represent an animal approximately the size of the Virginian Deer.

Cervalces americanus (Harlan) (?).

Cervus americanus HARLAN, Faun. Amer., 1825, p. 245.

Cervalces americanus SCOTT, Science V, 1885, pp. 420-422; Proc. Acad. Nat. Sci., Philad., July 1885, pp. 181-202, pl. 2.

In the collection from the Frankstown Cave are a number of fragments, which belong to four or five individuals (Nos. 11,037 to

⁴ Memoirs Amer. Mus. Nat. Hist., IX, 1908, p. 205.

⁵ Memoirs Amer. Mus. Nat. Hist., Vol. IX, 1908, p. 205.

11,042). I have referred these to the genus *Cervalces* after carefully comparing the material with Professor Scott's description and illustrations of the skeleton in Princeton University. My principal reason for regarding the remains as those of *Cervalces* are the long beam, or pedicel, of the antler (partly preserved) and the accessory basal tubercles between the inner crescents of the upper molars. Unfortunately there is not in the present material a complete limb bone by which to establish accurate comparison with the specimen at Princeton. The structure of the limb and foot as preserved clearly indicates long and slender limbs, which are characteristic of *Cervalces*.

Family BOVIDÆ.

Boötherium bombifrons (Harlan).

Plates XIX, figs. 1-13, and XX, figs. 1-8, XXI.

Bos bombifrons HARLAN, Faun. Amer., 1825, p. 271.

Boötherium bombifrons LEIDY, Proc. Acad. Nat. Sci. Phila., VI, 1852, p. 71.

In the material from the Frankstown Cave are portions of three skeletons of very large animals, similar to those of recent Musk-oxen. No. 11,036 is by far the most completely preserved, but unfortunately the skull is represented only by the occipital condyles and a portion of the base of the cranium. In the description by Caspar Wistar (Trans. Amer. Philos. Soc. (N.S.) Vol. I, 1818, p. 379, Pl. XI, figs. 10-11) and also in Harlan's paper (*l. c.* p. 274) there is little or nothing said in regard to the structure of the occipital condyles and that region of the skull. Leidy on the other hand has furnished us with a thorough description and illustrations of the type material preserved in the Academy of Natural Science of Philadelphia. ("*Extinct species of American Ox*" Smithsonian Contribution to Knowledge, 1852, pp. 12-19, Pls. III-V). In more recent years we are indebted to Wilfred H. Osgood for a revision of the extinct Pleistocene Musk-oxen discovered and described from time to time (*Smithsonian Miscellaneous Collections*, Vol. XLVIII, Part 2, 1905, pp. 173-185, Pls. XXXVIII; and *Proc. Biol. Soc. Wash.*, Vol. 18, 1905, p. 223). After a long and careful study of the literature on the fossil Musk-oxen of America in connection with the material at hand in the Carnegie Museum and elsewhere I feel entirely convinced that Leidy was correct in assigning the specimens in the Philadelphia Academy of Science to a distinct genus, closely related to the recent Musk-ox. Unfortunately the

dentition and cranial elements in the material at hand are not satisfactory as a basis for the substantiation or rejection of Osgood's proposition to generically separate Leidy's types of *Boötherium*, consisting of two partially preserved skulls. I feel, therefore, that it is more prudent in connection with this report to provisionally accept Osgood's genus *Symbos*, while referring the remains before me to Leidy's genus *Boötherium*, inasmuch as they agree quite perfectly with the description and figures of Leidy, so far as comparison can be made. The only character which might ultimately be regarded as standing against referring No. 11,036 of the Carnegie Museum to *Boötherium* is the sudden upward flexion of the basisphenoid, which, according to Osgood, in the type of *Boötherium* "has its lower surface in the same horizontal plane as that of the basioccipital." Osgood apparently lays considerable stress on this feature, since he states that this character differs from what is found in all the other species. In a recent skull of a Musk-cow from the U. S. National Museum, No. 49,655, it is seen that the basisphenoid is on a more even line with that of the basioccipital and in general agreement with what Osgood says of the type of *Boötherium*. Since I have no skull of a male *Ovibos moschatus* for comparison, I am unable at this time to say whether or not this character differs in the two sexes.

Although the material before me is defective as to the cranium, in other respects it supplies much which has not heretofore been described. In order to more closely ascertain the relation between the recent and Pleistocene Musk-ox, as well as the Bison, I give in the following pages a comparison of these forms.

In my studies I have received the kind assistance of Messrs. Childs Frick and H. E. Anthony of the American Museum of Natural History and of Mr. C. W. Gilmore of the United States National Museum.

Mr. Frick kindly examined twelve skulls at the American Museum and reports to me the existence of considerable individual variation in the basioccipital-basisphenoid region in *Ovibos*, which is due to several factors; (1) the degree of ossification of the inferior surface of the basioccipital particularly the antero-external corners; (2) a certain actual angulation of the basicranial axis. Mr. Frick calls attention to the fact that a similar variable condition occurs in zebras and horses. He states that the character is not altogether due to age, as the angulation in individuals of approximately the

same age greatly differs at times. He called attention to the fact that Professor Osborn has touched on this "Cytocephaly" in his *Craniometry of the Equidæ*. He also states that a mature skull of *Ovibos* from North Grantland, No. 29,944, reveals a tendency to flatness over the basioccipital-sphenoid region, while a fairly aged skull, No. 29,042, from Aylmer Lake, Mackenzie, shows an opposite tendency, being relatively angulated, the basisphenoid depressed.

Mr. H. E. Anthony reports that he has examined a series of fourteen Musk-ox skulls, seven males and seven females, all from the same place and all comparable as to age, and states that the amount of variation in the angulation of the basioccipital-sphenoid region is not very great, and that there does not appear to be any correlation of variation with sex. That is to say, the average difference between males and females in this respect is no greater than the individual variation found in a series of males and females. He states that it is his opinion that the character of this region in the fossil specimen would be of rather slight diagnostic value in view of what might be seen in a series of recently collected specimens.

Mr. C. W. Gilmore reports that he carefully examined the basiptyergoid region in six skulls of *Ovibos*, two males and two females and two young (sex of latter undetermined, but probably female). He says that the basisphenoid region in the males has a decidedly steeper upward pitch than in the females, though there is some variation in the degree of steepness.

Cranium. (Pl. XIX, fig. 7.) The occipital condyles are sessile, as in the recent Musk-ox, evenly rounded from the ventral to the posterior-superior face, with the lateral portion of the articulation for the atlas encroaching upon the base of the paroccipital process and not showing the deep excavated area between the latter process and the condyle, which is characteristic of the recent bison and of *Bos*. The foramen magnum is relatively small, as in the type described by Leidy. The paroccipital process is heavy, trihedral on cross-section, quite like that in the recent Musk-ox, and entirely unlike the attenuated condition found in the bison. The condylar foramen is placed further forward than in cattle or even further forward than in *Ovibos* and in this respect also agrees with Leidy's description of the genus. The basioccipital is broad, as in *Ovibos*, and has a rugose inferior surface, especially behind, where there is an unusually large pair of tubercles, abutting against the accessory facets on the anterior portion of the

occipital condyles, while further forward is a second pair of rugosities, separated from the former by a rather broad valley across the base of the cranium abutting against the basisphenoid. The median line of the basioccipital has a quite deep groove, which is bridged over near the posterior suture, forming a foramen. This feature seems to vary in the recent Musk-ox, especially in the young and fully adult or old, according to earlier observers. Sir John Richardson states that in more adult Musk-oxen this groove is replaced by a median ridge, while in the young there is a mesial furrow in the basioccipital (*The Zoology of the Voyage of H. M. S. Herald*, Vertebrates, 1854, p. 69). Osgood also speaks of the young *Ovibos* as having a median depression of the basioccipital, *l. c.* p. 178. The suture between the exoccipital and basioccipital is quite open, especially on the upper surface, or across the region of the medulla oblongata, indicating that the specimen is not old. The basioccipital and basisphenoid are completely coalesced. The latter bone is broken off immediately in front of the pterygoid process, which abuts against the alisphenoid, but enough is preserved to indicate that it is suddenly reflexed upwardly, differing in that respect from the type of *Boötherium*, which according to Osgood has this region more nearly on a horizontal line with the basioccipital. The external auditory meatus is not large and is placed on a horizontal line slightly above the occipital condyle as in *Ovibos* and higher than in *Bison*. The pit for the tympanohyal is of the same proportionate size as in the Musk-ox, while the tympanic bulla is apparently of relatively smaller size.

Dentition. (Pl. XX, figs. 5-6) C. M. No. 11,036. The first and second upper molars of the right side are provisionally referred to the same specimen. They pertain to an adult, though not old, individual. The characteristic features are identical with those of *Ovibos*, except their larger size. As in the Musk-ox these teeth are hypsodont, without cement or accessory cusps. The external walls have their styles of the same relative development as in *Ovibos*, the lakes are narrow and remain open, and the pit produced by the confluence of the walls of the inner crescents is present, as in the recent genus.

VERTEBRÆ.

Atlas. (Pl. XX, figs. 1-2.) The atlas is a massive bone. In bulk it equals or even exceeds that of *Bison americanus* or *Bos taurus*. The articulating surface for the occipital condyle is quite as broad as in

the Bison, and exceeds it in vertical diameter; it is considerably shallower and the accessory facet for the basioccipital takes up a much larger area, especially below the inferior margin of the articulation for the condyle, forming a broad shoulder, which acts as an effective lock on extreme downward flexion of the head. The neural canal appears to be small in proportion, when compared with that of a Musk-cow, and the accessory facets are smoother, having a more completely polished surface to conform to that of the basioccipital. In the fossil under description the spinous process is larger and the posterior portion of the transverse process has a greater downward dip than in the recent form.

When the atlas under description is compared with that from Eschscholtz Bay, described and figured by Sir John Richardson,⁶ there appear to be a number of similar characters in the two specimens, which differ from *Bos taurus* and *Bison americanus*. Among the more important of these are: the downward pitch of the posterior portion of the transverse process, which is greater than in the recent genera, this downward pitch causing the transverse process to embrace a greater area of the facet for the axis than is usually seen in the recent forms; the more even concavity of the articulation for the occipital condyle; and the very heavy lateral borders of the cotylæ, on which are located accessory facets for the lateral prolongation of the occipital condyle, suggesting similar facets in the atlas of the Musk-ox. The inferior accessory facets are also very prominent in the fossil atlas under description, but this feature is perhaps sexual, or otherwise a variable character, since I find it well developed in a skeleton of *Bos taurus* in the Carnegie Museum and Mr. Alban Stewart⁷ states that the skull of *Bison occidentalis* of the Lawrence Museum does not have the rugose knob-like projections just anterior to the condyles.

Axis. The axis is badly mutilated, but enough is left to show that the centrum is relatively shorter and broader than in either *Bos taurus* or the American Bison. It differs further by the absence of the sharp ventral keel, so characteristic of both the recent forms; the presence of large and rather deep pits on the anterior lateral margin of the pedicel immediately above the articulation for the atlas; and the smaller arterial canal, which pierces the anterior portion of the

⁶ *The Zoology of the Voyage of H. M. S. Herald*, 1854, Vertebrates, pp. 43-45, Pl. XII, figs. 1-4.

⁷ *Kansas Univ. Quarterly*, Vol. VI, 189, p. 128.

pedicel. What is left of the axis is, as might be expected, quite suggestive of the axis in the Musk-ox, including the short and broad centrum, the large and deep pits on the anterior upper margin of the articulation for the atlas, the absence of a decided ventral keel, the ill defined spout-shape and the thickness of the odontoid process.

On comparison with the description and illustrations of Richardson's *Ovibos maximus*,⁸ it is at once quite clear that the axis of the specimen from Eschscholtz Bay and that from the Frankstown Cave are closely alike both in size and general detail. As this axis from the Frankstown Cave was found articulated with the atlas and condyles of the skull previously described the association is certain, and it suggests that Sir John Richardson may have separated the axis and atlas of the specimen from Eschscholtz Bay, placing the former with *Ovibos* and the latter with *Bison crassicornis*.

Cervical vertebræ. (Pl. XX, figs. 1, 2, 5, 6.) The short and heavy centrum of the third cervical vertebræ of the specimen under description lacks the sharp ventral keel, which is prominent in *Bos taurus* and *Bison americanus*, and much more closely suggests that of *Ovibos*. The transverse process is also at a greater angle than in *Bos* or *Bison* and has less distinct anterior and posterior divisions. The spinous process, though broken off, indicates a spine fully as prominent as in *Bos* or *Bison*, while the neural and the arterial canals are smaller.

A fourth or fifth cervical is represented by the centrum and the greater portion of the transverse process. The latter is more distinctly divided into anterior and posterior processes than in the third vertebra just described. Otherwise there is little or no difference between the two, judging from the material at hand. The seventh cervical is not present, so that close comparison with that described and figured by Sir John Richardson as the first dorsal cannot be made.⁹

Upon the whole the neck is short and heavy, displaying many features analogous to those in the Musk-ox and less like *Bison* or *Bos taurus*.

Dorsal Vertebræ. (Pl. XX, figs. 3-4.) A series of dorsal vertebræ are referred to No. 11,036, the same individual described above. These vertebræ are more or less mutilated, especially in the region of the neural spine; the latter process being incompletely preserved

⁸ *Voyage of H. M. S. Herald*, 1854, pp. 25-28, Pl. XI, figs. 2-4.

⁹ *l. c.* p. 51, Pl. XI, fig. 6.

in every case. However, the centra are complete and display a number of features more closely resembling those in the Musk-ox than in *Bos* or *Bison*. In the anterior series of these dorsals the centra are less opisthocœlous, shorter, heavier, and the ventral keel less developed than in the genera just mentioned. Further back the dorsals have the centra provided with a more definite ventral keel, but not so strong as in *Bison* or *Bos*. The intervertebral canal is not transformed into a foramen, as in the latter genera, and in that respect is more closely conformed to the condition found in *Ovibos*.

Lumbar Vertebrae. (Pl. XX, figs. 4, 8.) Four lumbar vertebrae are represented. These vertebrae have the centra comparatively shorter and broader, the transverse process shorter and less attenuated than in *Bos taurus* or *Bison americanus*. The neural spine of an anterior lumbar vertebra is completely preserved. This spinous process is less elevated than those in the same region of the American Bison and more nearly like that in the domestic cow. The zygapophyses appear to have the completely interlocking sigmoid curved articulations found in *Bos* and also in *Bison*. This last feature of the zygapophyses is less completely shown in the skeleton of a Musk-cow used for comparison, but many features of the lumbar vertebrae in *Ovibos* are quite like those in the specimen under study. The description and illustrations of the lumbar vertebrae (found at Eschscholtz Bay) by Sir John Richardson admirably fit the lumbar vertebrae above described. The only important difference, which I can find, is that the length of the centrum in the specimen from Eschscholtz Bay is greater than in the specimen from the Frankstown Cave. The differences observed, except in the length of the centrum, may well be due to individual variation. That the vertebra from Eschscholtz Bay may be from a different section of the lumbar region, not represented in the specimen from the Frankstown Cave, is also to be considered.

Sacrum. The sacrum is represented only by the anterior portion of the centrum which furnishes no basis for comparison.

Caudal Vertebrae. The caudal region is represented by three vertebrae. These are relatively longer than in *Bison* and more closely suggest those of domestic cattle, except that the neural spine is less developed in the fossil form.

Ribs. The ribs are represented only by a few fragments, which indicate them to be more rod-like (especially those in the posterior

region of the thorax) than in the domestic cow or the recent American bison.

MEASUREMENTS.

<i>Cranium.</i>	Extreme width of the occipital condyle.....	126 mm.
	Antero-posterior diameter of occipital condyles, accessory facets not included.....	47 mm.
	Transverse diameter of occiput at external auditory meatus, estimated.....	227 mm.
<i>Atlas.</i>	Greatest transverse diameter.....	230 mm.
	Greatest antero-posterior diameter.....	135 mm.
	Greatest vertical diameter.....	120 mm.
<i>Axis.</i>	Greatest antero-posterior diameter of centrum, exclusive of the odontoid process; measurement taken ventrally.....	87 mm.
	Length of the centrum including the odontoid process; measurement taken ventrally.....	120 mm.
	Transverse diameter of centrum at the articulation for the atlas..	130 mm.
<i>Third cervical.</i>	Greatest antero-posterior diameter.....	65 mm.
	Greatest transverse diameter of articulating face of centrum.....	87 mm.
	Vertical diameter of articulating face of centrum; measurement taken on posterior face.....	80 mm.
	Transverse diameter including transverse processes.....	166 mm.
<i>Anterior dorsal vertebra.</i>	Greatest antero-posterior diameter of centrum	60 mm.
	Transverse diameter of centrum including facets for the head of the rib; measurement taken at posterior face.....	93 mm.
	Vertical diameter of centrum; measurement taken at posterior face	60 mm.
<i>Ninth (?) dorsal vertebra.</i>	Greatest antero-posterior diameter of centrum.....	66 mm.
	Transverse diameter of centrum including facets for the head of the ribs; measurements taken on posterior face.....	77 mm.
	Vertical diameter of centrum.....	60 mm.
<i>Lumbar vertebra, from the middle of the series.</i>	Greatest antero-posterior diameter of centrum.....	70 mm.
	Greatest transverse diameter of centrum; measurements taken on posterior face.....	90 mm.
	Vertical diameter of centrum.....	55 mm.

FORE LIMB.

Scapula. A few fragments of the proximal portion of a scapula are of the proper proportions to go with the axial skeleton above described, and are provisionally referred to the same specimen. These fragments show that the scapula is not unlike that of the recent American bison, except for its slightly larger size. The post-spinous fossa was possibly relatively wider than in the recent ox, or in *Bison*,

but this cannot be entirely proven, since the true contacts of the different fragments cannot be established.

Humerus. The humerus of the right limb is represented by the proximal and distal end and the greater portion of the shaft. This bone is very similar to that in *Bison* and *Bos*. The diameter of the proximal end is no greater than in a fully adult or old bison bull, and the different rugosities for muscular attachments are equally prominent, except the ulnar portion of the greater tuberosity, which is smaller in the fossil and more nearly like that in the Musk-ox. The deltoid ridge is also more gently curved and less rugose than in either the domestic cow or the recent bison, and resembles that in the Musk-ox. The distal trochlea is wider than in the bison bull, used for comparison, the median articulating ridge more gently rounded, the median groove shallower, the capitellum somewhat narrower, and the antero-posterior diameter of the articulation as a whole greater, while the external and internal epicondyles are actually smaller. The broad ulnar trochlea and olecranon fossa and the narrow capitellum are characters which suggest those in the Musk-ox, while the gently rounded median ridge of the articulation is unlike what is seen in either of the three species, with which comparison has been made.

The deep pit in the anconeal cavity of the remains from Eschscholtz Bay described by Sir John Richardson (*l. c.*, p. 56) is not present in the fossil humerus under description. This pit is present in the humerus of the American bison used by me for comparison, and is possibly a varying character, since Richardson states that this cavity is not present in the humerus which he referred to *Bison priscus*.

Radius. The radius, which belongs to the same fore limb described above, is represented by the proximal and distal ends. The articulation for the humerus fits neatly in the distal trochlea of the humerus, except the broken area on the ulnar angle of the head, and leaves no doubt in my mind as to the correct association of these parts.

In turning to Sir John Richardson's description and illustrations (*l. c.*, p. 57, Pl. XV, figs. 3 and 4) there is a remarkable similarity both in size and detailed structure, the specimen in hand being slightly smaller in size. The articulation for the capitellum is narrow in comparison with that of the humerus just described, and the median ridge is gently convex from side to side and more continuous in its fore-and-aft direction than that in the recent bison, more nearly resembling what is observed in the Musk-ox. The contact with the

ulna is broad, indicating a broad olecranon process, which would be naturally anticipated in view of the breadth of the trochlea of the distal end of the humerus. The distal end of the radius has its outline more quadrate than in the recent bison or the domestic cow. This is chiefly due to the greater development on the dorso-ulnar angle, the bone in this region having a greater antero-posterior diameter than in *Bison* and relatively greater than in the domestic cow. The posterior face is also more convex than in the latter species. As a consequence of this difference in diameter the articulation for the carpus in the fossil is greater in its fore-and-aft direction than that in *Bos*, or the recent bison.

Ulna. The ulna is represented only by a portion of the distal end of the shaft, which is solidly coössified with the shaft of the radius.

Carpus. The carpus is represented by four bones, the scaphoid, the magnum, the unciform, and the pisiform.

Scaphoid. The antero-posterior diameter of the scaphoid at first glance is seen to be greater than is the case in the bison bull used by me for comparison, while the transverse diameter is very little greater. The general outline of the bone is thus seen to differ from that in the recent bison and the domestic cow, and is very like that in the Musk-ox. The articulation for the radius is more uniform in width in its antero-posterior direction than in the *Bison*, which is chiefly due to the greater development of the overhanging ledge articulating with the lunar in the *Bison*. In the latter the ascending palmar hook is also more truncated and much more deeply furrowed on the radial side than in the fossil. When compared with the scaphoid of the Musk-ox all the above-described characters in the specimen found in the Frankstown Cave agree quite closely. Distally the palmar portion of the facet for the trapezoid slants upward and inward, so that it occupies a somewhat radial position, while in *Bison americanus* and *Bos taurus* as well as *Ovibos moschatus* the corresponding facet has a more directly distal position.

Magnum. The magnum is relatively broader, shorter, and shallower than in the *Bison*. The anterior portion of the facet for the scaphoid is less concave, as is also that for Mc.III; otherwise there is no difference of importance in this bone in the two genera compared.

Unciform. The unciform differs from that bone in the *Bison* by having the posterior portion of the facet for the lunar broader and

less oblique. In the fossil this is entirely due to the greater development of the unciform in this region. In the recent form on the other hand there is a facet of considerable size near the base of the palmar tuberosity which articulates with a similar facet on the palmar tuberosity of the lunar on extreme flexion of the carpus. This arrangement of facets is not present in the fossil under study. What flexion there was in the carpus of this genus was taken care of by the posterior extension of the facet for the cuneiform and by the broad posterior portion of the facet for the lunar. In the Bison the facet for Mc.IV has encroached on the palmar process, causing that part of the facet to become concave fore-and-aft, while in the fossil the facet is plane fore-and-aft, the palmar process supporting no part of this facet.

Pisiform. The pisiform has a longer and less truncated shaft than the corresponding bone in the Bison. The shaft is slightly curved, but not as much as in the Musk-ox. In the latter the shaft of the pisiform is much more attenuated antero-posteriorly and of relatively greater vertical diameter than in the fossil under study.

Metacarpals. The distal end and a considerable portion of the shaft of the coössified metacarpals, or cannon-bone, is preserved. The shaft has not the median longitudinal groove on the dorsal face and large nutrient foramen near the distal end, so characteristic of the recent bison and the domestic cow. On the posterior face of the shaft near the distal end is a minute foramen, much smaller than that in *Bison* and agreeing better with the minute foramen in the recent Musk-ox. The latter also lacks the median groove on the dorsal face of the shaft referred to above. The fragment of the cannon-bone of the fossil and the cannon-bone of the Musk-ox are, except in size, remarkably similar in their detailed structure, including the excavated area between the distal trochleæ, which is wider proximally than distally in both species, while in the cow and recent bison this excavation is subequal throughout.

The breadth of the distal trochleæ of the above described cannon-bone agrees fairly well with Leidy's measurements of the metacarpal from Missouri ("*Extinct Species of American Ox*," p. 19).

Phalanges. (Pl. XIX, figs. 8-10, 11-13.) The proximal row of phalanges are heavier and longer than the corresponding bones in the recent bison. They are also spread further apart distally and suggest more nearly those in the recent Musk-ox. The median row of

phalanges have approximately the same proportions as in *Bison*, the distal trochlea being a little narrower. It is thus seen that, upon the whole, the proximal and median phalanges agree both in proportion and structure with those in the Musk-ox. This is further emphasized when the ungual phalanx is studied. In *Bos taurus* and *Bison bison* the terminal phalanx is rather low, with a broad plantar surface, and evenly rounded and rugose external surface, an uneven internal surface, which on the whole, slants upward and outward to meet the external surface in a decided ridge better defined near the anterior point of the bone than further back, but forms an even and gradual forward and downward slope from the articular surface for the median phalanx to the distal apex. In the fossil, on the other hand, the terminal phalanx is higher and narrower, the dorsal ridge having a considerable convexity fore-and-aft, the plantar surface comparatively narrow, and the internal face more nearly vertical, forming a less perfect trihedron than the ungual of the cow and the bison and more like that in the *Ovinæ*. With the exception of the smaller size and relatively greater width of the plantar face of the ungual in the recent Musk-ox it answers very nearly the description of the specimen from the Frankstown Cave.

HIND LIMB.

The hind limb is represented only by a few fragments, of which the pes is by far the best preserved.

Calcaneum. (Pl. XIX, figs. 1, 4.) The calcaneum of the right pes is complete. In its relative proportions and detailed structure it is quite like that bone in the recent Musk-ox. The bone is fully as large as that in an adult bull of *Bison bison*, but the tuberosity back of the articulation for the astragalus is longer and less expanded at the free end; the fibular articulation is less developed transversely; the greater process of the distal end, especially along its dorsal border, is also somewhat longer and slender, and the articulation for the cuboid has a smaller angle with the shaft of the bone, or more nearly parallels the long axis of the bone.

Astragalus. (Pl. XIX, fig. 2.) The astragalus is shorter and broader than that in *Bison bison* and the fibular condyle of the proximal trochlea is less overhanging; otherwise there is not much dissimilarity displayed by this bone in the two forms. The comparison of the astragalus of the recent Musk-ox with the present form reveals

a closer similarity between them than with the American Bison. In measurement the astragalus agrees quite well with that mentioned by Dr. Leidy in his description of *Boötherium cavifrons*.

Cubo-navicular. The cubo-navicular associated with No. 11,036 is represented only by the navicular portion, but in a second specimen, No. 11,036a, referred to the genus, this bone is better preserved. The chief difference from the cubo-navicular in *Bison bison* appears to be in the narrower and more slanting position of the facet for the distal end of the calcaneum.

Cannon-bone. (Pl. XIX, fig. 3.) The cannon-bones of both hind feet are represented by the greater portion of the shafts, a portion of the proximal end, and the distal end. They are of larger size than those mentioned by Leidy in connection with his description of *B. cavifrons*. The shaft bears a rather closer resemblance to the same bone in the American Bison, and is more evenly rounded than in the recent Musk-ox. However, the median longitudinal groove is broader and shallower than in *Bison* and more nearly resembles the groove in *Ovibos*. The nutrient foramen in this groove near the distal end is also like that in the recent Musk-ox, being very minute in size, while that in *Bison* and the domestic cow is large. Except for its larger size the distal trochlea does not differ much from that in *Bison bison*. In *Ovibos* the distal end is more suddenly expanded than in the metatarsals under description.

MEASUREMENTS.

FORE LIMB.

<i>Scapula.</i>	Anterior-posterior diameter of glenoid cavity.....	74 mm.
	Greatest antero-posterior diameter at glenoid cavity, the coracoid tubercle included.....	97 mm.
	Transverse diameter of glenoid cavity.....	64 mm.
<i>Humerus.</i>	Greatest antero-posterior diameter of head.....	150 mm.
	Greatest transverse diameter of head.....	130 mm.
	Greatest transverse diameter of distal end.....	110 mm.
	Greatest antero-posterior diameter of distal end.....	78 mm.
<i>Radius.</i>	Greatest antero-posterior diameter of head.....	58 mm.
	Greatest transverse diameter of head.....	108 mm.
	Transverse diameter of articulation with carpus, ulnar portion excluded.....	87 mm.
	Antero-posterior diameter of articulation with carpus (measurement taken at the articulation for the scaphoid).....	45 mm.
<i>Scaphoid.</i>	Antero-posterior diameter.....	60 mm.
	Transverse diameter.....	36 mm.
	Vertical diameter.....	40 mm.

<i>Metacarpals.</i> Transverse diameter at distal articulations.....	88 mm.
Antero-posterior diameter at distal articulations.....	52 mm.
<i>Proximal phalanx.</i> Length.....	91 mm.
Width, proximal end.....	46 mm.
<i>Median phalanx.</i> Length.....	55 mm.
Width.....	44 mm.
<i>Ungual phalanx.</i> Length.....	96 mm.
Width.....	32 mm.

HIND LIMB.

<i>Calcaneum.</i> Greatest length.....	165 mm.
Length of tuberosity above the articular surface for the astragalus.	106 mm.
Transverse diameter of free end of the tuberosity of calcaneum....	44 mm.
Greatest transverse diameter of calcaneum at articulation for astragalus.....	60 mm.
<i>Astragalus.</i> Greatest length, measurement taken of fibular side.....	81 mm.
Transverse diameter, distal trochlea.....	57 mm.
<i>Metatarsals.</i> Total length (measurement taken at the cuneiform facet).	285 mm.
Transverse diameter of distal trochlea.....	82 mm.
Antero-posterior diameter of distal trochlea.....	47 mm.

The second individual, No. 11,036*a*, consists of a portion of a hind foot and other various fragments. The calcaneum of this second individual is equal in length to that of the specimen just described, but it is slender, which may possibly be due to sexual or individual variation.

The remains of the third individual No. 11,036*b*, (Plate XXI) represents a very young animal. A portion of a disarticulated skull together with foot-bones and other fragments are associated. The great thickness of the cranial wall, a characteristic feature of *Boötherium*, as well as *Ovibos*, leads me to place these young remains with *Boötherium*. The base of the cranium presents certain features analogous to those of the *Cervinæ* (*Alces*) and also to those of the *Bovinæ* (Bison). The chief characteristic to which allusion is made is the excavated area between the occipital condyle and paroccipital process, together with the similar position of the condylar foramen, which causes some hesitation in referring the specimen to the Musk-oxen. The paroccipital process itself is, however, much heavier and more rounded than in the *Bovinæ* or the *Cervinæ*. At the postero-internal angle this process is well connected with the lateral border of the occipital condyle by means of a sharp ridge. Apparently this ridge from the base of the paroccipital process gives evidence of a

further filling out of the excavated area along the lateral side of the condyle in animals of more mature age. There is a much greater space between the paroccipital process and the tympanohyal pit than in either the *Bovinæ* or the *Cervinæ*. In the latter the tympanohyal pit is crowded close to the anterior face of the paroccipital process, while in the specimen under description the space between process and pit is filled in, first with an extended base of the paroccipital process, and secondly with a considerable portion of the otic bulla. This is more nearly like the condition found in *Ovibos*. The bulla itself is of a sharper conic shape and the walls thicker than in *Ovibos*. The supraoccipital and frontal are narrower than in *Bison*, the horn-cores further in advance of the fronto-parietal suture; the small bosses themselves consisting of a very thin bony shell covering extraordinarily large cavities beneath, which extend over a considerably greater area of the frontal than the immediate base of the horn-core.¹⁰ One rather striking feature of the maxillary is the absence of the sudden constriction of the muzzle in the region of the infra-orbital foramen, so characteristic of the *Cervinæ* and *Bovinæ*, and more nearly like what is observed in *Ovibos*.

There are no accessory columns on the milk or permanent teeth of the specimen under description. The absence or presence of these pillars between the inner crescents of the molars in *Ovibos* appears to be varied according to Lönberg, Osgood, and others, and was most likely also the case in *Boötherium*.

In the Carnegie Museum Loan Collection there is a portion of a skull of a fossil Musk-ox, No. 203, which Mr. J. B. Hatcher regarded as an adult specimen of *Ovibos cavifrons*.¹¹ While the occipital plate and the base of the cranium of this specimen agree perfectly with Leidy's description and illustrations of his *Boötherium cavifrons* and *bombifrons*, the region between the horns, as well as the horn-cores themselves, in the Steubenville skull appear to differ both from Leidy's type and from the Alaskan specimen described by Osgood as *Symbos tyrrelli* (*l. c.*, p. 176). The Steubenville skull agrees with the two latter in having the concave and roughly pitted area between the

¹⁰ At this age these animals probably had no horny shell-covering, which appears to agree with the slow development of the horns in the recent musk-ox during the first eight or ten months, according to Lönberg (*Proc. Zool. Soc., London*, June 1900, p. 687).

¹¹ *Science*, N. S., XVI, 1902, pp. 707-709.

horns bounded, as Osgood states, by the horn-cores laterally, by the superior border of the occipital plate posteriorly, and quite likely by the rugose shelf-like rim anteriorly. This rugose area apparently did not extend as far forward as in Leidy's type, or Osgood's *Symbos tyrrelli*, and there is a distinct median groove (not a ridge, Cf. Osgood) traversing the area fore-and-aft, analogous to that in the male of *Ovibos moschatus*, though shallower. This groove is more distinctly marked anteriorly and posteriorly than it is directly between the horns, where it is in fact very nearly obsolete. This area as a whole closely suggests an abraded surface. The bases of the horn-cores cannot be said to expand over the fronto-parietal region, as in the full-grown male of *Ovibos moschatus*, although the pitted surface of the frontals no doubt had a similar function, and agrees with Leidy's type and the Alaskan skull described by Osgood. In the present specimen the horn-cores are flatter and more abruptly turned downward than in Leidy's and Osgood's types, and somewhat suggest the condition in a female *Ovibos moschatus*. The internal faces of the horn-cores are not so close to the temporal region of the cranium as in *Ovibos*. Judging from the outward direction at the point where the horn-cores are broken off, I would say that probably their apices were relatively further out from the skull than in a full-grown animal of the recent genus.

In these early Musk-oxen there is quite likely a greater variation in the fronto-parietal region and in the horn-cores themselves than we are aware of at the present time, and accordingly we should use caution in the comparative study of this region of the skull. Furthermore, Lönberg¹² has shown quite clearly that in *Ovibos moschatus* a great change takes place in the fronto-parietal region and the horns during the development of the bull-calf into the fully adult and old animal.

SUBORDER *PERISSODACTYLA*.

Family TAPIRIDÆ.

Tapirus terrestris (Linnæus) (?).

Hippopotamus terrestris LINNÆUS, Syst. Nat., Ed. 10, 1758, p. 74.

The genus *Tapirus* is represented by fragments (No. 11,049) of the left ramus of a mandible containing the first and second premolar

¹² *Proc. Zool. Soc. Lond.*, June 1900, pp. 687-718.

teeth. The teeth belong to the permanent series, and are very little worn, presenting characters quite similar to those of the recent animal.

Family EQUIDÆ.

Equus sp. (?)

No. 11,048 represents the epiphysis of a metapodial and a number of lower cheek-teeth of an immature horse. The specimen shows no characters by which specific identification can be made.

Order **PROBOSCIDEA**.

Family ELEPHANTIDÆ.

Mastodon¹³ **americanus** (Kerr). Pls. XXII-XXIII.

Elephas americanus KERR, Anim. Kingdom, 1792, p. 116.

The American Mastodon is represented in the material from the Frankstown Cave by one adult, and at least six or seven young, as originally stated by Dr. Holland.¹⁴ All the material is extremely fragmentary, except a mandible, No. 2332, of an immature animal. Disarticulated parts of *ossa inominata* enable me to determine that the remains of a number of young were left in the cave with the bones of at least one adult.

The lower jaws already referred to by Dr. Holland, (*l. c.* 238) deserve a more detailed description, especially the dentition which perhaps is the most complete as yet found.

These jaws are of a quite young animal, younger than the specimen from Newburg, Orange county, New York, which formed part of the material upon which Dr. John D. Godman based his publication in the Transactions of the American Philosophical Society, 1830, Vol. III, and which was more accurately figured by Dr. Isaac Hays, *ibid.*,

¹³ Dr. O. P. Hay correctly maintains that the name *Mammut*, first employed by Blumenbach, has technical priority over the generic name *Mastodon* Cuvier. However, all writers, except Dr. Hay, who follows Blumenbach, have used Cuvier's name *Mastodon*, and we follow the general usage, especially in view of the fact that Professor Osborn recommends (*Philogeny of the Proboscidea*, Bull. Geol. Soc., XXIX, 1914, pp. 133-137), that *Mastodon* should be adopted by the Paleontological Society as one of the *Nomina conservanda*.

¹⁴ Ann. Carn. Mus., Vol. IV, 1908, pp. 231 *et. seq.*

Vol. IV, 1834, p. 324, pl. XXVI, figs. 1-2. The region of the symphysis has a greater downward thrust and the vertical ramus rises more in advance in the specimen under description than in the specimen from New York. Otherwise the contour of the ramus in the two are quite alike. The lower or median incisor in the specimen at hand is scarcely more than half the size of that described by Godman and further differs from the latter by having no enamel. The second pair of incisors are broader than the median pair and differ from them in having their crowns composed of three closely connected portions; the lateral and median portions of subequal size, and the internal superior portion smaller and closely adhering to the median tubercle. The second pair of incisors are smaller than the tusk-like median pair and are directed more upwardly. The edentulous portion of the alveolar border forms a sharp edge and shows a diastema of 102 mm. from the second incisor to the first cheek-tooth. The first deciduous cheek-tooth has received little or no wear, and well displays the tubercular structure, which may be better appreciated by referring to the plates. There is an anterior and posterior cingulum as well as a mammilated one externally, while internally the tooth is smooth. The second deciduous cheek-tooth is considerably larger than the first, but is in detailed structure quite like it, though the posterior cingulum on this tooth rises to the importance of a low cross-crest. The crowns are rather brachyodont and the roots are strong in the deciduous series of cheek-teeth. The first permanent cheek-tooth is just appearing through the alveolar border and has received practically no wear. This tooth has three well defined cross-crests as well as anterior and posterior cingula. The fourth cheek-tooth is buried deep in the angle of the jaw but its crown is well developed and displays a structure quite identical with that of the tooth in advance of it, which has just been described.

MEASUREMENTS.

Total length of ramus from the condyle to and including incisors.....	410 mm.
Length of diastema.....	110 mm.
Depth of ramus at deciduous M ₁	66 mm.
Depth of ramus at deciduous M ₂	65 mm.
Length of total cheek-dentition.....	215 mm.
Length of deciduous M ₁	29 mm.
Length of deciduous M ₂	42 mm.
Length of deciduous M ₁	67 mm.
Length of deciduous M ₂approximately.....	82 mm.

Order GLIRES.

SUBORDER SIMPLICIDENTATA.

Family SCIURIDÆ.

A number of isolated teeth and other fragments, No. 11,294-11,299, which apparently pertain to the family *Sciuridæ*, were found among the mass of material in the Frankstown Cave. The fragmentary condition of the remains and the lack of material for comparison does not for the present admit of referring the fossils to any of the numerous genera and species of this family.

Family MURIDÆ.

SUBFAMILY CRICETINÆ.

***Peromyscus canadensis* Miller.**

Peromyscus canadensis MILLER, Proc. Biol. Soc. Wash., VIII, 1893, p. 55.

Right and left lower jaws, Nos. 11,285, 11,283, together with an additional lower jaw, No. 11,284, some fragments of upper jaws, and isolated teeth are referred to the genus *Peromyscus*. As careful comparison as it is possible to make shows this material to be most nearly like *Peromyscus canadensis*. The anterior lobe of the first lower molar, as in most specimens of *P. canadensis*, does not extend so far inward, and is more truncated than the inner angle of this lobe in *P. leucopus*. In *P. maniculatus* the anterior lobe of the first lower molar is also like that in the fossil specimens, but the inner border of the tooth is more developed and the third lower molar in most specimens of the recent species compared, is smaller, especially in the fore-and-aft diameter. In the fossil specimens from Frankstown Cave the lower cheek-teeth are slightly narrower than in recent specimens, with which comparisons have been made, but the fragmentary condition of the fossil material together with the limited number of recent forms available for comparison, does not seem to warrant the establishment of an additional species.

SUBFAMILY NEOTOMINÆ.

***Neotoma* ? sp.?**

A fragment of a lower jaw, No. 11,300, which has the first molar in place, somewhat resembles that tooth in *Neotoma pennsylvanica*

Stone. The last lobe of the tooth, however, does not extend outwards in the same manner. In the fossil the indentation is a long slant from the postero-external angle forwards and inwards, while in *Neotoma pennsylvanica* the posterior lobe is more nearly ovate in outline and the indentation has a U-shape. In the fossil the anterior inner indentation is not as deep as in the recent species. The material before me is unfortunately too fragmentary to permit a satisfactory comparison with the recent species.

SUBFAMILY MICROTINÆ.

Evotomys gapperi (Vigors).

Arvicola gapperi VIGORS, Zoöl. Journ., V, 1830, p. 204, pl. IX.

Among the fragmentary remains referred to this species is a portion of a right mandible with the incisor, and first and second cheek-teeth, No. 11,260. This specimen compares so closely with corresponding parts of a recent specimen in the Carnegie Museum taken at Cresson, Cambria County, Pennsylvania (No. 460) that it is referred to this form.

Microtus pennsylvanicus (Ord).

Mus pennsylvanicus ORD, Guthrie's Geography, 2nd Ed., 1815, p. 292.

In the collection are a few fragments identified as *Microtus*. Of these the best material consists of the following: No. 11,254, left lower jaw, with incisor and first and second cheek-teeth; No. 11,257, left lower jaw with incisor and second cheek-tooth; No. 11,258, lower first molar of left side; No. 11,259, first lower molar. Upon comparison with No. 531 and other material of the recent osteological collection of *Microtus* in the Carnegie Museum, it is found that the fossil and recent specimens closely agree.

Genus SYNAPTOMYS.

Three lower jaws of the right side with complete dentitions and a number of isolated upper and lower teeth compare best with the genus *Synaptomys*. I am provisionally regarding this material as representing a new subspecies, which may be named and described as follows:

Synaptomys cooperi annexus. subsp. nov.

Type: Lower jaw of right side with complete dentition, No. 11,270.

Paratypes: Two lower jaws of right side with complete dentitions, Nos. 11,271, 11,272.

With this material are also associated fragments of maxillaries with teeth, No. 11,269 and a number of isolated teeth Nos. 11,273, 11,280.

Horizon: Pleistocene cave-deposits.

Locality: Frankstown Cave, near Hollidaysburg, Blair County, Pennsylvania.



FIG. 4. *Synaptomys cooperi annexus* Peterson, subsp. nov.

Type. C. M. Cat. Vert. Foss. p. 270. 2.5 nat. size.

Principal characters. Incisor relatively stout when compared with the recent species, but the root does not pass beyond the third cheek-tooth. The external anterior angle of the first cheek-tooth is better developed and the indentation is less perceptible than in the recent species, with specimens of which it has been compared. The two external indentations, back of the anterior angle of the first molar, and also the external indentations of the two succeeding molars are deeper and narrower than in the recent species. The first upper cheek-tooth of the right side is almost identical with the corresponding tooth of recent specimens, with which comparison has been made.

Measurements may be obtained from the illustration (Fig. 4).

Family DIPODIDÆ.

SUBFAMILY ZAPODINÆ.

Zapus hudsonius (Zimmermann).

Dipus hudsonius ZIMMERMANN, Geogr. Geschichte d. Mensch. u. Vierfüß, Thiere II, 1750, p. 358.

Two upper jaws, Nos. 11,289, 11,290, and lower molars, Nos. 11,291, 11,292, are referred to *Zapus hudsonius*. The alveolus for the functionless first cheek-tooth, or premolar, is present in both of these fragments of the upper jaw. With the exception of the slightly smaller transverse diameter the detailed structure of the teeth is so close to *Zapus hudsonius* that I do not greatly hesitate in referring the fragments to that species.

Family ERETHIZONTIDÆ.

SUBFAMILY ERETHIZONTINÆ.

In the material from the Frankstown Cave there is a portion of a skull and fragments of limb bones, No. 11,153, a maxillary bone, lower jaws, and other fragments which represent North American Porcupines. Upon comparison with the recent form one, or possibly two, anatomical features appear, which might be regarded as of sub-specific or possibly specific value. These differences are recorded in the following description, without proposing a new species. The material is, however, fully adequate as a type, and figures are given in connection with this paper.

***Erethizon dorsatus* (Linnæus) (?)**

Hystrix dorsatus LINNÆUS, Syst. Nat., Ed. 10, 1758, p. 57.

The remains from the Frankstown Cave are as large as a fully adult specimen of *E. dorsatus*. The sudden rise of the palate in front of the molars is as in *E. dorsatus*, but the palatine foramen is larger. The alveolar region of the maxillary is higher, the optic foramen and the second large foramen, which enters the narial passage, are situated higher than in the recent skull used for comparison. The base of the

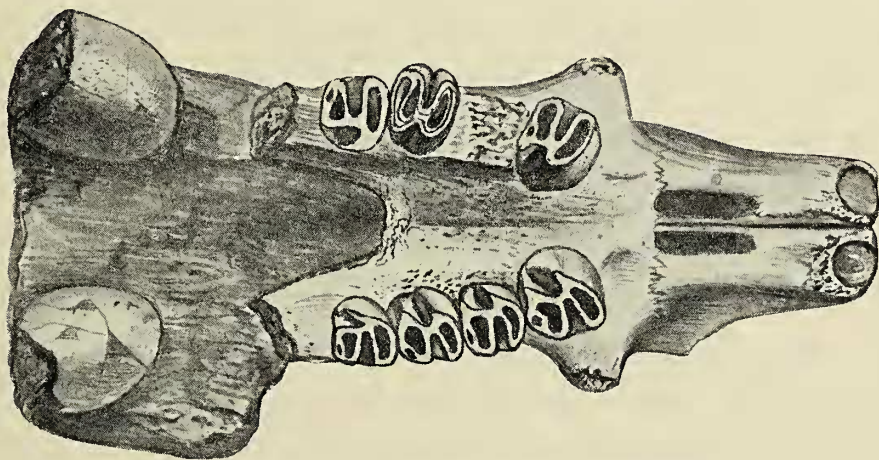


FIG. 5. Palatal view of skull of *Erethizon*,
C. M. Cat. Vert. Foss. No. 11,153. Nat. size.

slender process on the maxillary, which bounds the lower part of the antorbital fossa, is preserved, while the upper margin of this fossa is lost. However, this fossa, as well as the large infraorbital foramen, appear to possess characters similar to those found in the recent American Porcupine.

Teeth. The internal inflection of the enamel of M^3 extends to the alveolar border, as in some of the recent forms. The external inflection is also deep. These two characters agree with Professor Cope's description of *Erethizon cloacinus*;¹⁵ but are found also to differ much in specimens of *E. dorsatus*, as was pointed out both by Leidy¹⁶ and Cope.¹⁷ As in the recent form, the first cheek-tooth is larger than those behind, and the position of the dentition in the alveolar border has the same degree of convergence from back to front. The entire top and back of the fossil skull is wanting, due partly to crushing by the distal end of a femur lying across this portion of the cranium.

The most important differences between the recent and fossil specimens compared above, are: the higher alveolar region of the maxillary and the smaller dentine lakes in the cheek-teeth of the fossil skull; the greater mass of dentine in the teeth of the recent form, which is especially noticeable along the inner border of the teeth; in the fossil the inner lobes of the cheek-teeth are more evenly slant, while in the recent skull there is a smaller slant from the apex of the tooth to about midway to the alveolar border, so that the increase of the dentine is exposed more rapidly with wear in the recent skull, which I have used for comparison.

The fragmentary remains of limbs of *Erethizon* from the Franks-town Cave are quite similar to the corresponding parts of the recent porcupine. When more and better material of the Pleistocene forms are obtained it is entirely probable that we shall be obliged to separate them specifically from the recent American porcupines.

Besides the material described above there are numerous fragmentary remains of rodents and probably insectivores cataloged under No. 11,301, which must for the present remain unidentified. This is partly due to the lack of recent osteological material for comparison at the present writing.

¹⁵ Proc. Amer. Philos. Soc., 1871, p. 93.

¹⁶ "North American Rodentia," Report U. S. Geol. Surv., Vol. XI, 1877, p. 398.

¹⁷ "Vertebrate Remains from the Port Kennedy Bone Deposit," Jour. Acad. Nat. Sci., Philad., Vol. XI, 1897-1901, p. 199.

Order **LAGOMORPHA**.¹⁸Family **LEPORIDÆ**.

As in the Port Kennedy Cave of eastern Pennsylvania, the Frankstown Cave has furnished much material representing the hares. The variety found in the Conard bone deposit of northern Arkansas¹⁹ is, however, not in evidence in the collection from the Frankstown Cave, no remains of "Jack Rabbits" being found. Forty to sixty individuals are cataloged, of which about half represent young animals. While there are a number of nearly complete lower jaws, the crania are rather poorly preserved. Vertebræ, limb and foot bones, on the other hand, are often complete and furnish satisfactory means of comparison. When the great range of variation in a given species of the recent hares (pointed out by Allen²⁰) is taken into consideration it is thought best, at present, to refer these remains of the Frankstown Cave to recent species.

Lepus americanus Erxleben.

Lepus americanus ERXLEBEN, Syst. Regn. Anim., 1777, p. 330.

Of this species over forty individuals are represented by scattered teeth, fragments of crania, and lower jaws. A number of vertebræ, limb and foot bones are more or less complete, and compare quite perfectly with recent specimens of *Lepus americanus*.

Lepus sylvaticus Bachman.

Lepus sylvaticus BACHMAN, Journ. Acad. Nat. Sci. Phila., 1887, p. 403.

To this species are referred about twenty individuals after a minute and painstaking comparison. While a number of features might be regarded as of specific value, (such as the apparently smaller or more delicate incisor, narrower skull, and less sessile posterior lobe of M₃ in the fossil material) I have not felt justified in making a specific distinction, because the crania are very poorly represented and in the

¹⁸ So far as I can see, Mr. Gidley's arguments (Science N. S. Vol. XXXVI, 1912, pp. 285-286) in favor of erecting the Lagomorphs into an independent order are cogent, and tend to a more satisfactory systematic arrangement.

¹⁹ Memoirs Amer. Mus. Nat. Hist., Vol. IX, 1908, pp. 198-199.

²⁰ U. S. Geol. Surv. Terr., Vol. XI, 1877 (See especially table on p. 273).

second place the material representing the limbs, agrees perfectly with those of the recent form. The characters alluded to above may stand in abeyance until better crania are found in more perfect association with the appendicular skeleton.

Order **CARNIVORA.**

Family **CANIDÆ.**

Canis dirus Leidy.

Canis dirus LEIDY, Proc. Acad. Nat. Sci. Philad., 1858, p. 2.

Three or more individuals of this species are represented in the material from the Frankstown Cave. Of these specimens No. 11,023 is a skull, and is referred to Leidy's species without hesitation.²¹ The specimen, when compared with the type, is of slightly smaller size and the carnassial tooth has proportionally a smaller antero-posterior diameter. The last mentioned character may be due to the fractured condition of this tooth in the type, or possibly to faulty delineation.

Nos. 11,024 and 11,026 (Plate XVII, fig. 11) are chiefly fragmentary lower jaws, while No. 11,022 consists of a portion of the skeleton. This skeleton was not found articulated, but has been associated for convenience in studying the material.

Marked features in the lower dentition of the three individuals (Nos. 11,022, 11,024, 11,026) from the Frankstown Cave are the relatively smaller antero-posterior diameter of the carnassial and the greater transverse diameter of the heel when compared with a number of individuals from the La Brea Asphaltum deposits of California. The premolars in the wolf from the Frankstown Cave on the other hand do not differ much from the La Brea specimens, in their proportions or detailed structure. The ramus itself is approximately of the same size in the eastern and western forms (See plate XVII, fig. 11).

The remains of the skeleton of the Frankstown Cave, No. 11,022, are more robust than in the recent wolf. If the foot bones are correctly associated with No. 11,022, it seems that, while the metacarpals are nearly proportionate in size to those of *Canis lupus*, the metatarsals are shorter.

²¹ Leidy, Jour. Acad. Nat. Sci. Philad., Vol. III, p. 167, Pl. XVII, figs. 11 and 12.

***Canis priscolatrans* Cope (?)**

Canis priscolatrans COPE, Jour. Acad. Nat. Sci. Phila., (2), Vol. XI, 1899, p. 227, Pl. XVIII, figs. 3-3g.

A smaller wolf than the one named above was found in the Frankstown Cave. Two or more individuals may be represented, the material consisting of the back part of two lower jaws of one individual, and a number of vertebræ, as well as limb and foot bones, which appear to represent at least two animals. In this lot, which has been associated under Nos. 11,027, and 11,027a, there is also an upper canine tooth.

Unfortunately there are no upper cheek-teeth with the remains of this smaller wolf, and the association of the remains with Cope's type, which consists of three superior molars, must be regarded as only provisional. The material at hand indicates an animal approximately the size of the type of *C. priscolatrans* in the Academy of Natural Sciences, Philadelphia.

The upper canine is but very little larger than that of *Canis latrans* and it differs from the latter only by the more perfectly oval cross-section of the fang. The lower jaws indicate an animal somewhat larger than an average sized coyote. As is the case with the upper canine, the lower is only slightly larger than that tooth in *Canis latrans*, while the dentition back of the canine has more nearly the proportions shown in the coyote. A prominent feature of the inferior premolars of the present form is the well developed posterior accessory cusp on all the teeth except P₁. In the coyote P₄ has the accessory cusp well developed, P₃ has sometimes a faint trace of one, while P₂ lacks this tubercle altogether. In *Canis dirus* P₃ and P₄ are provided with accessory cusps, while on P₂ there is no trace of it. The cusps and crests of the premolars and the carnassial are quite as acute as in *C. latrans*.

This smaller species from the Frankstown Cave, having regard to the accessory cusps, apparently had advanced further towards the recent wolf than *Canis dirus*. The specimens of *C. lupus* used by me for comparison have a well developed accessory cusp on P₂ of both sides.

Two complete radii, fragments of the ulna, and a number of foot bones and ribs of No. 11,027a, are in my judgment somewhat too small to belong with No. 11,027 just described, and may pertain to

a smaller individual of the same species, or possibly represent a third species from the Frankstown Cave. These bones are no larger than those of a coyote and resemble them most closely.

Family MUSTELIDÆ.

SUBFAMILY MELINÆ.

Mephitis mephitica (Shaw).

Viverra mephitica SHAW, Mus. Leverianum, 1792, p. 171.

This species is represented, in the collection from the Frankstown Cave, by a lower jaw, No. 11,056, containing the two last premolars

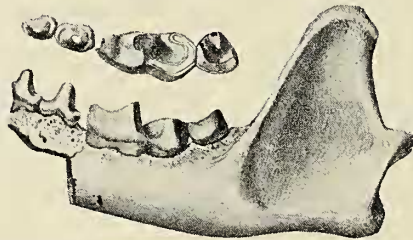


FIG. 6. *Mephitis mephitica* (Shaw) (?).
C. M. Cat. Vert. Foss. No. 11,056. Nat. size.

and the molars. Associated with this jaw is an upper tooth (M^1) of proportionate size and worn in the same degree as the teeth of the lower jaw. In comparing these teeth with Professor Cope's description (*Jour. Acad. Nat. Sci.*, XI, 1897-1901, pp. 232-233) they agree closely enough to place it provisionally with the recent species. It is noticeable that the metaconid is larger than in *Spilogale putorius*, but I would not at present regard this as of sufficient importance to base upon it the establishment of a separate species. The larger metaconid suggests *M. mephitica*, but the contour of the ramus, *i. e.* the lesser rise of the posterior portion of the jaw together with the smaller size and other features, might perhaps be regarded as excluding the specimen from *M. mephitica*.

The upper tooth (M^1) is well worn, but the two parallel crests near the external face, the deep pit-like median basin and the prominent posterior ledge, as in the recent species, are easily seen. This upper tooth is of course provisionally associated with the inferior ramus described above, but I feel quite satisfied that it pertains to the same individual.

Brachyprotoma obtusata* (Cope).

Mephitis obtusatus COPE, Jour. Acad. Nat. Sci. Philad., Vol. XI, 1897-1901, p. 236.

Brachyprotoma obtusatus BROWN, Mem. Am. Mus. Nat. Hist., IX, 1908, p. 177.

Two pairs of lower jaws, Nos. 11,057, 11,058, portions of an upper jaw and other fragments, No. 11,057a, are referred to this species. The specimens correspond most closely with the species from the Port Kennedy Bone deposit, except the carnassial tooth, which, according to Cope's description of *M. obtusata*, has a greater antero-posterior diameter than in Cope's type.

The upper teeth and the fragments of the maxillary, No. 11,057a, agree fairly well with the description and figures of *Brachyprotoma*

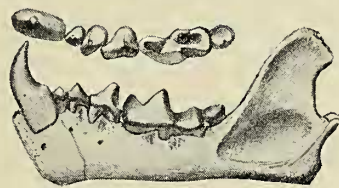


FIG. 7. *Brachyprotoma obtusata* (Cope).

C. M. Cat. Vert. Foss. No. 11,057. Nat. size.

pristina by Mr. Barnum Brown.²² The present specimen is somewhat smaller and may well belong with either of the lower jaws of *B. obtusata* described above. The teeth were not found in position in the jaw, but they all apparently represent the same side (the left maxillary) and most likely belonged to the same individual. The apex of the canine is broken off, but the base of the crown and the fang are perfectly preserved and agree with Mr. Brown's description of *B. pristina* in being proportionally larger in size and much longer than wide. The base of the crown is not as distinctly separated from the root by a shoulder, or cingulum, as in either *Conepatus* or *Mephitis*. P³ is placed very close to the canine and otherwise agrees with Brown's description by being longer than wide and having no anterior cingulum. The carnassial and M¹ agree mainly with the characters of *B. pristina* mentioned by Brown, *l. c.* p. 178.

[*NOTE: The generic name *Brachyprotoma* coined by Mr. Barnum Brown, is formed from the Greek words *βραχύς* and *Προτομή*. As the latter noun is feminine, the specific adjectives should agree in gender, as in the case with the new species described by Brown, who, however, by an oversight neglected to change Cope's *obtusatus* to *obtusata*. W. J. Holland]

²² Memoirs Amer. Mus. Nat. Hist., Vol. IX, Part IV, 1908, p. 178.

Family URSIDÆ.

Arctotherium haplodon (Cope). Pls. XXIV-XXV.

Some of the material representing bears from the Frankstown Cave is referred to the genus *Arctotherium*. The type of *Arctodus* Leidy²³ consists of the second inferior molar of the left side. This type is apparently lost. The best representation of it is given by Francis S. Holmes in his "Post-Pleiocene Fossils of South Carolina," Pl. XXIII, figs. 3 and 4. In his description (*l. c.* p. 115) Holmes states that the outer side of the tooth is deeply and equally bilobed, and that the grinding surface has a superficial depression surrounded by a chain of hill-like tubercles, of which the largest pair extend across the anterior part of the crown.²⁴ These statements appear to be born out by the illustrations, especially the outline contour of the crown-view, which has an external emargination equally dividing the front and back portions. This is not true of the material from the Frankstown Cave, and it appears that Professor Cope found that the corresponding teeth in the material from the Port Kennedy Cave have the portion anterior to the emargination greater than that back of it. The side view of this tooth on the same plate in Holmes' article certainly indicates more developed tubercles than in the corresponding teeth from the Frankstown Cave, while in Leidy's original article it is said: "the triturating surface is more generally level, and represents less disposition to the formation of cusps." Whether or not these illustrations and a portion of the description by Holmes is absolutely correct, or whether *Arctodus* is congeneric with *Arctotherium*, are questions which may perhaps never be entirely satisfactorily determined.

In the fauna of the Frankstown Cave there are two or more of these bears represented. No. 11,020 is the larger, but No. 11,020a is associated with the same species, as has been determined by the close correspondence of the material with Professor Cope's description.²⁵

²³ Proc. Acad. Nat. Sci. Philad., 1854, p. 90. If the type of *Arctodus* is ever found we may discover that *Arctotherium* and *Arctodus* are congeneric, in which case *Arctodus* holds priority.

²⁴ This description appears to answer more nearly the second lower molar of *Tremarctos* than that of *Arctotherium*.

²⁵ Proc. Amer. Philos. Soc., Vol. XII, 1871, p. 96; "Vertebrate remains, Port Kennedy Bone Deposit," Jour. Acad. Nat. Sci. Phila., Vol. XI, 1897-1901, p. 221.

The skull is represented only by a few fragments, the largest being a portion of the alisphenoid, the temporal region, including a considerable portion of the squamosal, the glenoid cavity, the ectotympanic portion of the bulla, and the mastoid process. Of these parts the glenoid cavity presents an antero-posterior surface greater than what is shown in a large specimen of *Ursus gyas* Merriam, the mastoid portion is smaller, while the distances between the foramen ovale, foramen rotundum, and the foramen opticum are closer together. The distance between the postglenoid and mastoid processes is especially short, indicating the basal region of the cranium to have been short, when compared with *Ursus gyas*.

Of the smaller specimen, No. 11,020a, (Pl. XXIV, figs. 1-2) the horizontal rami are well represented. On comparing these fragments with the corresponding parts of *Tremarctos* the notable feature of the double masseteric fossa, which Cope mentioned (*l. c.* p. 221), is clearly seen. This fossa, usually single, in *Arctotherium* and *Tremarctos* is divided by a crest of bone, which extends obliquely downwards and backwards from below the base of the coronoid process to the lower border of the angle, thus dividing the masseteric fossa. Upon further comparison it is observed that the rami of the two here compared are quite alike, except the region between the molar series and the canine. In *Arctotherium* this region is relatively greater than that in the recent genus, in which the premolars are much crowded. In *Arctotherium* there is in fact a short diastema between the second and third lower premolars, a condition which slightly approaches the long diastema in this region of the lower jaws of *Ursus gyas* and other large species.

The upper dentition is represented only by the fourth premolar and the molars (Pl. XXIV, figs. 5-6). All of these teeth agree closely with the description furnished by Cope (*l. c.* p. 222). A second, smaller individual, No. 11,020a, also answers Cope's description. When compared with the recent genus *Tremarctos* there is a remarkable similarity in P^4 , while in the molars there are differences. Thus M^1 in an unworn tooth of *Tremarctos* is relatively longer and narrower, the tubercles along the inner face are less clearly defined, only presenting a rugose crest, while in *Arctotherium* they are distinctly marked, though closely united. M^2 in *Tremarctos* is nearly of the same proportionate length as in *Arctotherium*, but in the latter the tooth is wider anteriorly and narrower posteriorly. In other words

the grinding face on M^2 of *Arctotherium* is of a sub-triangular outline, while in *Tremarctos* the external and internal borders are more nearly parallel.

As in the upper series, the lower teeth (Pl. XXIV, figs. 1-4) agree in the main with the description by Professor Cope (*l. c.* p. 223). Premolars one, two, and three are single-rooted. In the Spectacled Bear of South America these teeth are so crowded that premolar two, above and below, are placed externally in the alveolar border.²⁶ In *Arctotherium*, on the other hand, these teeth occupy a more liberal space in the jaws as noted above. P_4 may be said to have two roots, though coalesced and closely crowding against M_1 . This condition is also true of *Tremarctos*. The protoconid of M_1 is larger than in bears generally, and also relatively larger than in *Tremarctos*. In *Arctotherium* there is a slight external invagination of M_2 , which divides the crown of the tooth into a larger anterior and a smaller posterior portion. In *Tremarctos* the anterior and posterior parts are more nearly equal. M_3 is proportionally smaller than in *Tremarctos* and also smaller than in *Ursus gyas*. With the exception of the differences noted, the lower molars of *Tremarctos* and *Arctotherium* are quite similar in structure and relative diameters.

The vertebral column and ribs are represented only by fragments. The axes of two individuals are fairly well preserved. They may belong to Nos. 11,020, and 11,020a. The centrum is proportionally long and the posterior portion of the neural spine large and broad, when compared with the axis of *Tremarctos* or other recent bears; otherwise the axis does not differ much from that of recent species. A posterior dorsal and the last lumbar here associated are also fairly well preserved and present no unusual features (See Pl. XXV, figs. 6, 8, 9).

Fragments of fore and hind limbs (Pl. XXV) have been associated with No. 11,020, which appear to agree in proportion to the size of the cranial elements described above. The scapula consists of the proximal and distal ends. The glenoid cavity has a long oval outline, due to the great antero-posterior diameter. The coracoid eminence is very well developed, which is partly the cause of the great antero-posterior diameter of the glenoid cavity. As is usual in the recent species, the spine rises close to the articular surface and

²⁶ In the small bear of Sumatra, *U. malayanus*, P^2 is also external in the jaw.

terminates inferiorly in a heavy acromion process, which extensively overhangs the glenoid cavity when viewed directly from the side. The fragment representing the vertebral border is that portion directly opposite the spine and it is quite heavy and spongy. The antero-posterior diameter of the glenoid cavity is 88 mm.; the transverse diameter 55 mm.

In comparing the above described fragments with the corresponding portions of *Tremarctos* it is quite evident that the blade in the fossil has not that extreme curvature immediately above the glenoid cavity seen in *Tremarctos*. Due to this concavo-convexity of the shoulder-blade in the latter genus the spine is of course vertically very convex, which does not appear to be the case in *Arctotherium*. In the fossil there is a very prominent ridge separating the subscapular and scapular head of the triceps surfaces, which are much less prominent in *Tremarctos*.

The humerus is represented by the distal end of the left side. This is larger than that of a very large specimen of *Ursus dalli gyas*.²⁷ The entepicondylar foramen is present as in *Tremarctos*. The intertrochlear ridge, separating the capitellum and the trochlea, is more plainly indicated than in either *Tremarctos* or the Alaskan Bear, used for comparison. The transverse diameter of the distal articulation is approximately 107 mm. and the antero-posterior diameter at the inner border of the trochlea is 55 mm. The greatest transverse diameter of the distal end is approximately 155 mm., while that of the specimen C. M. Cat. Rec. Mamm. No. 2693, is 125 mm. The shaft near the distal end has not that inward sweep, which gives the unusual obliquity to the articulating trochlea seen in *Tremarctos*, and is in that respect more like the *Ursinæ* in general.

The shaft of the ulna more nearly suggests that of *Tremarctos* and has different proportions from that of *Ursus gyas*. Though considerably longer than in the latter, the proximal portion measured across the lesser sigmoid notch, is actually of smaller diameter, while distally it is more rounded and has the different muscular attachments less marked than in the Alaskan species. In other words, the shaft is less rapidly tapered than in the recent form. The top of the

²⁷*Ursus dalli gyas*, described by C. Hart Merriam in Bulletin No. 41 of the North American Fauna. U. S. Dept. Agriculture Feb. 9, 1918, pp. 124-6. The basal length of No. 2,693 C. M. Cat. Recent Mamm., is 415 mm. or 25 mm. longer than the type of *U. dalli gyas*.

olecranon process is broken off and so also is the coronoid process. The ulnar face of the olecranon process is less channeled than in the Alaskan species and the antero-posterior diameter at the greater sigmoid cavity is no greater than in the recent species.

A second somewhat smaller specimen, No. 11,019, has the ulna complete, (See Pl. XXV, fig. 2). The slenderness of the ulna is better shown in this individual. In detailed structure this bone is practically identical with the ulna of the larger individual just described. The olecranon process has not the prominent rugosities for the attachment of the different muscles, as in *Ursus gyas*. As already stated, the bone has a characteristic roundness of shaft, as in *Tremarctos*, and a slenderness which is not found in any other recent bears with which I have compared it.

The radius of No. 11,019 (Pl. XXV, fig. 1) is preserved, except the anterior and radial portions of the head. The slenderness of this bone is at once noticeable, and the lack of prominence of the ridges which form the boundaries of the muscular attachment of the shaft is a characteristic feature, when compared with *Ursus gyas*, and again suggests that of *Tremarctos*, except the lesser curve of the shaft in *Arctotherium*.

A third metacarpal of the right side (Pl. XXV, fig. 1) is preserved with No. 11,020. This bone is very nearly a third larger than the corresponding bone in the large specimen of *Ursus gyas*, C. M. No. 2,693, here used for comparison. The dorsal portion of the distal trochlea is more oblique than in the latter, but otherwise there is little or no difference in the details of structure of this bone in the two specimens. In *Tremarctos* the shafts of the metacarpals are more depressed and broader than in *Arctotherium*.

In No. 11,019 the manus is fairly well preserved and indicates at once that the slenderness of the limb is likewise carried out in the foot (See Pl. XXV, fig. 5). In this individual the metacarpals are as heavy as those in the Alaskan Bear referred to, but they are of greater length. Some bones of the carpus, especially the scapho-lunar, are actually smaller in size, but of equal and even greater height than the corresponding bone of the Alaskan specimen. In this individual, No. 11,019, the dorsal face of the trochlea of Mc. III has the same curious obliquity shown in the larger individual just described. In the scapho-lunar under description there is no facet for a radial sesamoid, while in *Tremarctos* there is a facet, which articulates with a

bone of considerable size. In the Sumatran Bear this sesamoid is smaller.

The hind limb and foot are not as well represented. The patella is broad, thin, and having relatively small vertical dimensions. The calcaneum of No. 11,020 is as long as that of a large specimen of *U. gyas*, but the transverse diameter of the *tuber calcis* is less and the rugosities for muscular attachments are also less developed, and not unlike what is seen in *Tremarctos*.

With No. 11,019 is associated a portion of a hind foot, including the cuboid, navicular, ectocuneiform, and a complete metatarsal I. Metatarsals III and V are represented by the proximal ends and Mt. IV by the entire shaft. The cuboid differs in details of structure from that of the Alaskan specimen used for comparison. In the fossil the articulating contacts for the ectocuneiform have a greater antero-posterior diameter, the facet for the navicular is more extensive antero-posteriorly, as well as being more nearly straight fore-and-aft and vertically. The greater antero-posterior extent of the facet for the navicular is due to the fact that there is developed on the postero-tibial angle a truncated process, which articulates above with the calcaneum and with the navicular on its tibial face. This process is slightly indicated on the cuboid of *U. gyas*, but takes no such prominent part in the articulations for the calcaneum and the navicular. The plantar hook on the navicular in *Arctotherium* is much better developed than in the Alaskan species, and there is apparently a distinct facet for the entocuneiform on the tibial angle of this hook, while in *U. gyas* there is no indication of such a facet. In correspondence with the facet on the cuboid that on the navicular has straighter lines and is not convex, as is the case of the facet for the cuboid in the Alaskan species. The ectocuneiform of the fossil has the plantar hook more greatly developed than in the recent form, otherwise there is little or no difference in the details of structure in this bone in the two genera.

Metatarsal I has a round shaft and is distinctly slenderer than in *U. gyas*. This is apparently true of the other metatarsals.

In *Tremarctos* the cuboid has the articulation for the astragalus along the entire proximal tibial angle of the cuboid, while in the Alaskan species it does not reach nearly so far, and in *Arctotherium* it ends approximately half-way to the plantar angle. Except for the difference noted and the relatively broader and flatter metatarsals,

there is upon the whole a close similarity between the tarsus and metatarsus (so far as the material permits of comparison) in *Tremarctos* and *Arctotherium*.

***Ursus americanus* Pallas.**

Ursus americanus PALLAS, Spicil. Zoöl, Fasc. XIV, 1780, pp. 5-7.

The Black Bear is represented in the cave fauna by a pair of lower jaws, No. 11,021, and a few other bones, which have been placed under the same number, inasmuch as they perhaps belong to the same individual. The dentition appears to agree quite perfectly with that of the recent Black Bear. The ramus, however, is proportionally shallow and slender when compared with that of the recent form. As the fossil is that of an animal not fully adult, this fact may in part at least account for the discrepancy. Furthermore, Professor Cope has shown²⁸ that the range of variation among the remains of the Black Bear found in the Port Kennedy Bone Deposit is similar to that seen in existing individuals.

Order **INSECTIVORA.**

Family **SORICIDÆ.**

SUBFAMILY **SORICINÆ.**

***Sorex frankstounensis* sp. nov.**

Type: Right mandible with all the teeth and a fragment of the left mandible with M_1 and M_2 , C. M. Cat. Vert. Foss., No. 11,159a.

Horizon: Pleistocene Cave Deposits.

Locality: Frankstown Cave, near Hollidaysburg, Blair County, Pennsylvania.

Among the recent shrews *Sorex personatus* and *S. albibarbis* compare most nearly with the materials under discussion. The new species represents an animal smaller than either of the latter species, but the jaws are similarly long and slender. The incisor is very long and slender, with three distinct tubercles on the upper border, back of the apex of the tooth. The antero-posterior diameter of P_3 is greater than that of P_4 , which is especially noticeable along the inner face. The tooth has a low but trenchant anterior cusp, a long heel, subtriangular in outline, with the sharp apex of the triangle directed

²⁸ Jour. Acad. Nat. Sci. Phila., Vol. XI, 1897-1901, p. 226.

forwards. In *S. personatus* this tooth is broader and of less antero-posterior diameter. The true molars are proportionally longer, slenderer, and more hypsodont than in *S. personatus*. M_3 in *S. frankstounensis* has a well developed posterior heel, while in the recent species (C. M. No. 653) here used for comparison, the heel of M_3 is much less developed. In the fossil specimens the crowns of the teeth are covered with a light brown pigment.

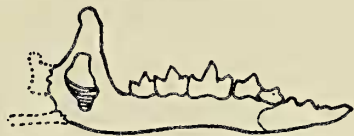


FIG. 8. *Sorex frankstounensis* Peterson, sp. nov.
Type. C. M. Cat. Vert. Foss. No. 11, 159a. X3.

MEASUREMENTS.

Total length of jaw including incisor to base of styliform process on angle of jaw.....	8.5 mm.
Length of premolars.....	1.5 mm.
Length of molars.....	3. mm.
Depth of mandible at M_1	1. mm.

Blarina brevicauda (Say).

Sorex brevicauda SAY, Long's Exped. to the Rocky Mountains, I, 1823, p. 164.

In the material from the Frankstown Cave there are a number of fragments of skulls, jaws, and other bones of shrews. The material was badly scattered through the entire mass of remains from the cave, making satisfactory study or classification almost impossible.

Nos. 11,166, 11,170, represent fragments of skulls, lower jaws, and teeth provisionally referred to *Blarina brevicauda*. Of these No. 11,166, the right lower jaw, with which has been associated an upper incisor tooth, has been carefully compared with Professor Cope's species *Blarina simplicidens* from the Port Kennedy Bone Deposits (Cf. Journ. Acad. Nat. Sci. Philad., Vol. II, Art. VIII, 1899, p. 219). From this comparison it is quite plain that the Frankstown specimen does not belong with *B. simplicidens*. P_1 upon which Cope based part of his specific determinations is unfortunately lost, but the last true molar is present and has a well developed heel as in *B. brevicauda*. A further comparison is made with a specimen of *Blarina brevicauda* taken at Ingomar, a suburb of Pittsburgh, and one taken in Butler

County, Pa. This comparison shows almost identical size, and osteological and dental structure. In comparing the Frankstown specimens with the illustrations in Dr. C. Hart Merriam's work on the Shrews (North American Fauna, No. 10, U. S. Dept. of Agriculture, Dec. 31, 1895, Pls. I, II) it is at once seen that both the fossil and the recent specimens here used for comparison are smaller than the type of *B. brevicauda* from Nebraska, which agrees with the specimens studied by Merriam and others. Merriam states that the largest specimens of *B. brevicauda* are from Western Nebraska, and that those from eastern Nebraska are larger than specimens from the Northern and Eastern states, while the smallest specimens are from Massachusetts.

Family TALPIDÆ.

SUBFAMILY TALPINÆ.

Genus PARASCALOPS True.

Parascalops, Proc. U. S. Nat. Mus., Vol. XVII, 1894, p. 242 (Type *Scalops breweri* Bachman).

This genus is represented by two or three individuals. Of these No. 11,067 is best preserved, consisting of the anterior portion of the skull, the left lower jaw minus the vertical ramus, fragments of vertebræ, and a few limb and foot bones. The genus was proposed by Dr. Frederick W. True (*l. c.* p. 242), who in a later publication furnishes us with a description of its anatomy together with a complete history of the genus. (Proc. U. S. Nat. Mus., Vol. XIX, 1897, pp. 67-77). The few differences in structural detail between the fossil specimens from the Frankstown Cave and *Parascalops breweri* Bachman, as described by True, may be of specific value, but I here prefer only to call attention to these differences, without at this time establishing a new species.

***Parascalops breweri* (Bachman).**

Scalops breweri BACHMAN, Boston Jour. Nat. Hist., Vol. IV, 1842, p. 32.

The skull of No. 11,067 is badly mutilated, only the front being preserved. The infraorbital foramen is large and bounded posteriorly by a slight bar of bone as in *Parascalops breweri* described by True (Proc. U. S. Nat. Mus., Vol. XIX, 1897, p. 71) and also as in the

European mole, *Talpa europæa*. In the fossil skull the lachrymal is broken, but the lower border of the lachrymal foramen is preserved and it agrees with *Parascalops* both in its large size and in its position, *i. e.* in front of and above the infraorbital foramen. In *Talpa* this foramen is also very nearly as large and similarly located.

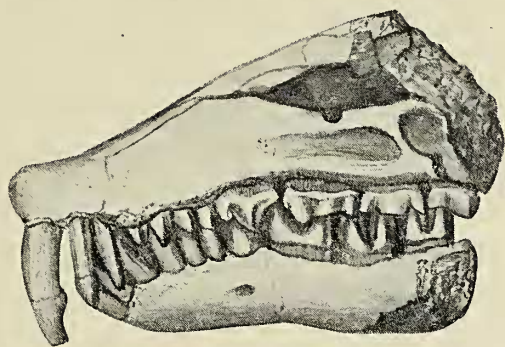


FIG. 9. *Parascalops breweri* (Bachman).
C. M. Cat. Vert. Foss. No. 11,067. $\times 3$.

As in *Parascalops breweri* the dental formula is: I_3^3 ; C_1^1 ; P_4^4 ; M_3^3 ; total 44. The first upper incisor agrees with the recent form in nearly all particulars. It is large, broad, flat, inclined inward and comes in contact with the first incisor of the opposite jaw. In more minute details I^1 differs from recent specimens in the somewhat greater convexity in front, in having smaller transverse and greater antero-posterior diameters, and the external accessory cusp located further down on the tooth than in *Parascalops breweri*, represented by C. M. Cat. Rec. Mamm. Nos. 609 and 610, and also in the specimen described and figured by Dr. True. The second incisor is slightly larger than the third, which agrees with the specimens in the Carnegie Museum, also agrees with the illustration, but not with the description, given by True. In the fossil, as in the recent specimens, I^2 and I^3 are smaller than I^1 , and are conical. The point of the canine is broken off, but from the size of the base of this tooth I judge that it was at least as large as in the recent specimens, with which it is compared, and no doubt had the same conical form. P^1 and P^2 are nearly subequal in size and conical, while the third is slightly larger, having the diameter fore-and-aft little greater than across. The posterior accessory cusp of P^3 appears to vary. In some of the recent specimens and also in the fossil skull in hand there is no posterior accessory cusp, while Dr. True describes a posterior accessory cusp as existing. P^4 is large, triangular, with a small anterior accessory cusp, a posterior trenchant margin, and, so far as comparison may be made, the tooth

appears to agree perfectly with that tooth in recent specimens. The molars also agree, the first being the largest, the second intermediate, and the third the smallest. In the fossil specimen the upper and lower jaws are interlocked, but it is possible to detect that the w-shaped cusps and the prominent internal basal ledges, which True describes, and which also are seen in recent specimens in the Carnegie Museum are practically the same.

The first lower incisor is lost, there is, however, evidence of an alveole for this tooth in the fossil jaw. I_2 appears to be rather larger than in recent jaws, while I_3 is approximately of the same size. The canine is about the same size as I_3 . In the interlocking condition of the upper and lower jaws of the specimen under description the crown and internal views are hidden.



FIG. 10. *Parascalops breweri* (Bachman). C. M. Cat. Vert. Foss. No. 11, 159. Nat. size. Two figures at left, humerus; figure at right, ulna.

In the fossil specimen from Frankstown Cave, C. M. Cat. Vert. Foss., No. 11, 159, the humerus is one-third longer than broad and the length and breadth of the clavicle are equal. This corresponds perfectly with Dr. True's description of these bones in *Parascalops breweri*. The radius has the same length as the humerus, the ulna is about one-fourth longer. The greater length of the ulna is chiefly due to the long and heavy olecranon process. There is close similarity between the humerus, radius, and ulna in *Parascalops* and the European mole (*Talpa europæa*).

Order CHIROPTERA.

SUBORDER MICROCHIROPTERA.

Family VESPERTILIONIDÆ.

SUBFAMILY VESPERTILIONINÆ.

Genus MYOTIS Kaup.

Myotis KAUP, Skizzirte Entw. Gesch. u. Naturl. Syst. d. Europ. Thierw., I, 1829, p. 106.

Fragments of lower jaws, isolated teeth, and other fragments representing four or five individuals of *Myotis* are found in the collection gathered at the Frankstown Cave. It is not possible to determine to which species of the genus *Myotis* this material pertains, because the specimens are inadequate for detailed comparative study.

POSTSCRIPT.

Since this paper went to press I have received a publication from the Carnegie Institution of Washington, issued in October, 1925, by Drs. John C. Merriam and Chester Stock. On p. 4 of this work the authors have proposed to separate the typical bears from *Tremarctos* and *Arctotherium*, designating the former as *Arctinae* and the latter as *Tremarctinae*. On p. 7 Merriam and Stock accept Leidy's genus *Arctodus* and say that "should the characters of *Arctodus* be shown eventually to agree with those of *Arctotherium*, the former name has priority, for *Arctodus* antedates *Arctotherium* Bravard."

In the specimen from the Frankstown Cave the skull of *Arctotherium* is poorly preserved, but what there is of it compares fairly well with the better preserved crania of *Arctotheres* described by Merriam and Stock. The most noteworthy difference in the lower jaw appears to be (judging from the illustrations given by Merriam and Stock) the relatively greater depth of the horizontal ramus of the lower jaw and the larger size of the paraconid of M_1 in *A. simum*. P^4 in *A. californicum* has the metacone smaller than in the specimen from the Frankstown Cave. Both upper and lower teeth in the latter are also apparently longer and narrower than in the Californian specimens and upon the whole more closely suggest the conditions found in *Tremarctos*. M_3 in *A. simum* has its triturating surface decidedly triangular, a characteristic feature in the greater number of recent ursines.

The figures and description of the appendicular skeleton of *Arctotherium* in the paper of Merriam and Stock appear to agree quite closely with the specimens from the Frankstown Cave and call for no comment.

O. A. PETERSON.

Carnegie Museum, Dec. 3, 1925.

EXPLANATION OF PLATE XVII.

Meleagris superba Cope (?) No. 11,053.

- FIG. 1. Right femur, from the front.
- FIG. 2. Scapula; view of proximal end.
- FIG. 3. Femur; view of distal end and shaft.
- FIG. 4. Portion of pelvis; external view.
- FIG. 5. Tibio-tarsus, right side.
- FIG. 6. Tarso-metatarsus, left; view of anterior face.
- FIG. 7. Tarso-metatarsus, left; view of lateral face.
- FIG. 8. Tibio-tarsus, left side.
- FIG. 9. Femur, left; view of distal end.
- FIG. 10. Humerus; anterior view of distal end.

Canis dirus Leidy, No. 11,022.

- FIG. 11. Lower jaw; view of external face.

(All figures one-half natural size.)



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FIGS. 1-10, *Meleagris superba* Cope (?).

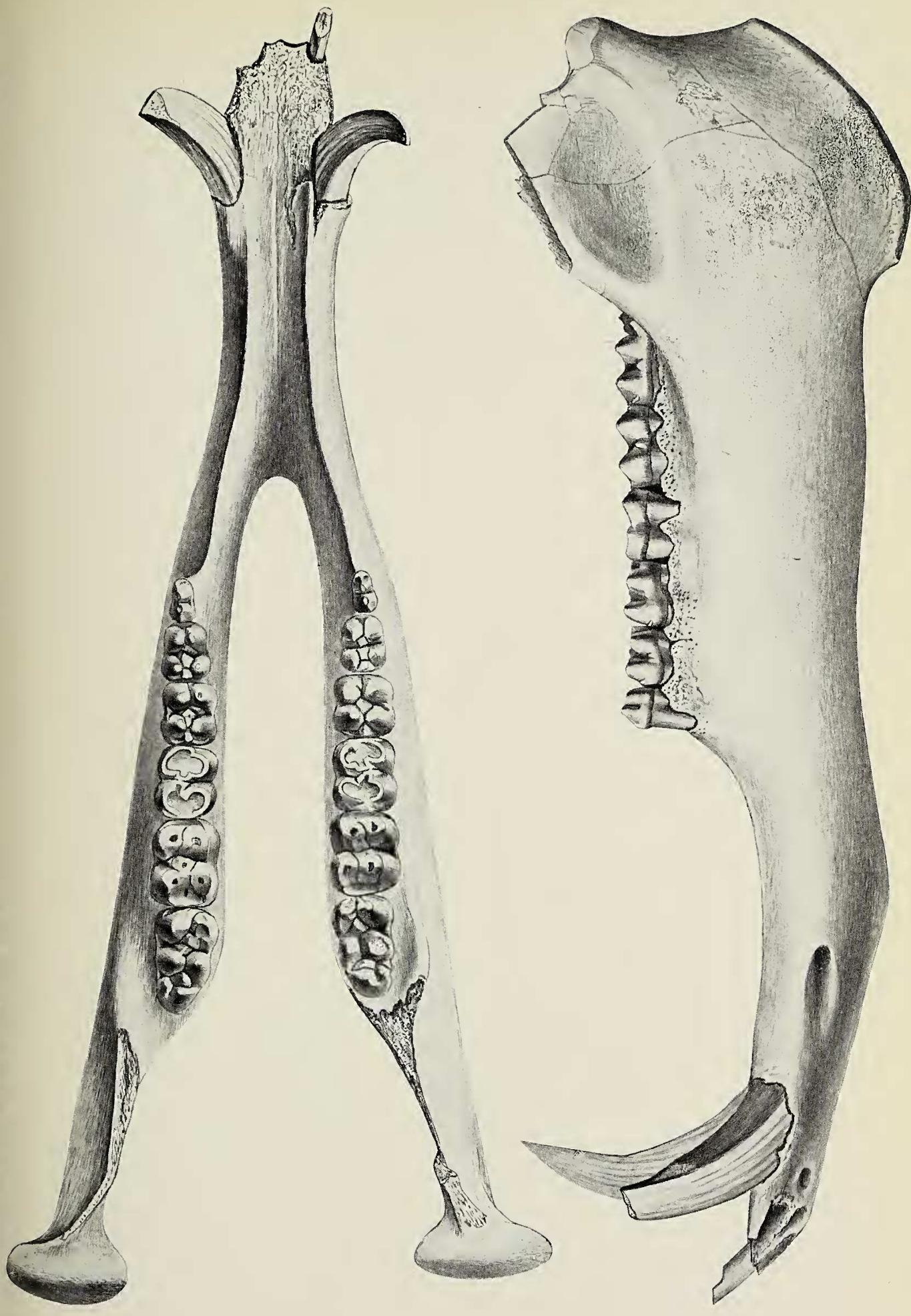
FIG. 11, *Canis dirus* Leidy.

EXPLANATION OF PLATE XVIII.

Mylohyus pennsylvanicus (Leidy).

UPPER FIGURE. Alveolar View of Lower Jaws, No. 2330.

LOWER FIGURE. External View of Lower Jaws, No. 2330.
(Two-thirds natural size.)

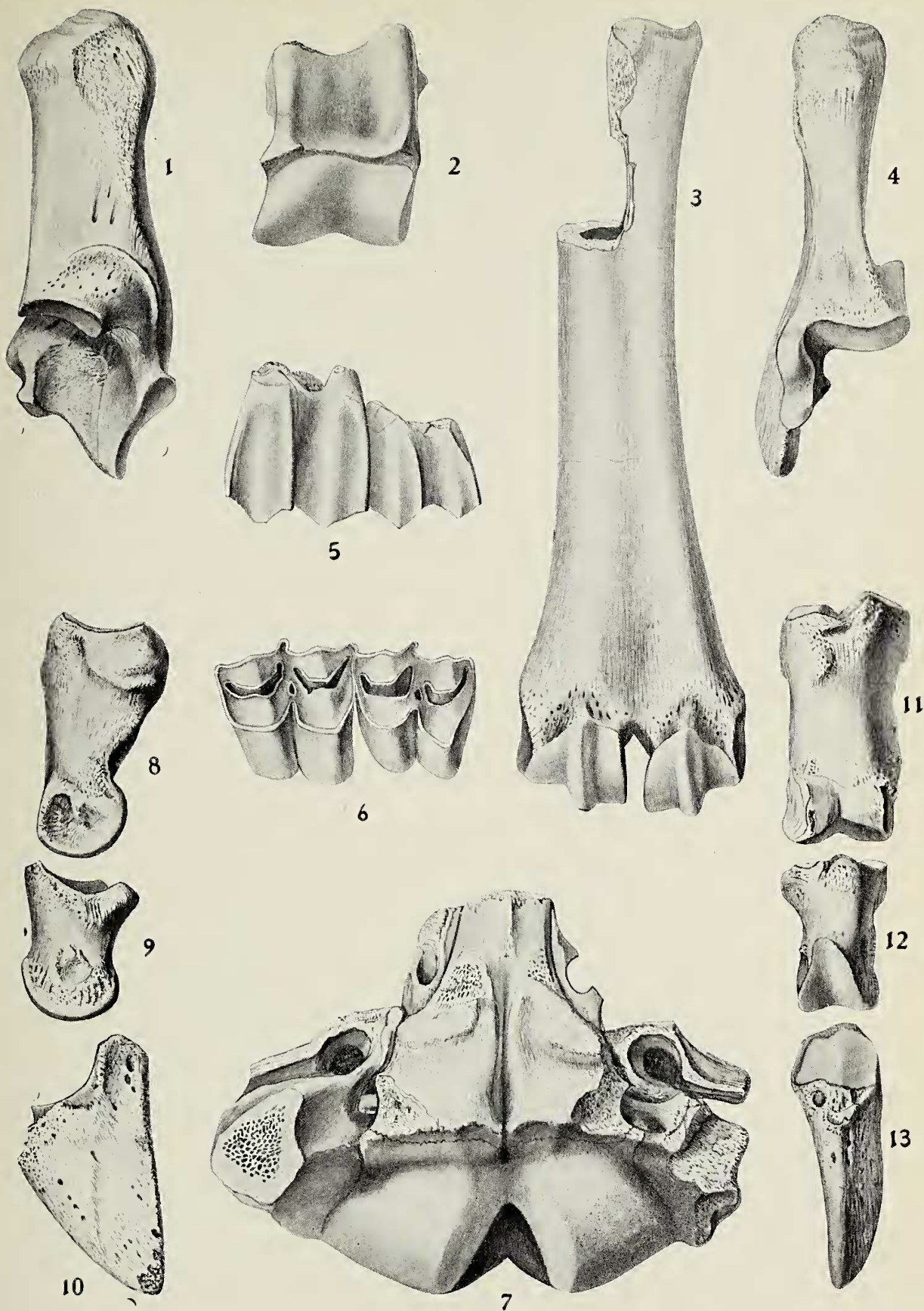


Mylohyus pennsylvanicus (Leidy). $\times \frac{2}{3}$

EXPLANATION OF PLATE XIX.

Boötherium bombifrons (Harlan). No. 11,036.

- FIG. 1. Calcaneum, tibial view.
FIG. 2. Astragalus of left side.
FIG. 3. Cannon-bone, dorsal view.
FIG. 4. Calcaneum, dorsal view.
FIG. 5. First and second upper molars, buccal view.
FIG. 6. First and second upper molars, view of grinding face.
FIG. 7. Base of skull.
FIGS. 8-10. First, second, and terminal phalanges, lateral view.
FIGS. 11-13. First, second, and terminal phalanges, dorsal view.
(All figures one-third natural size.)

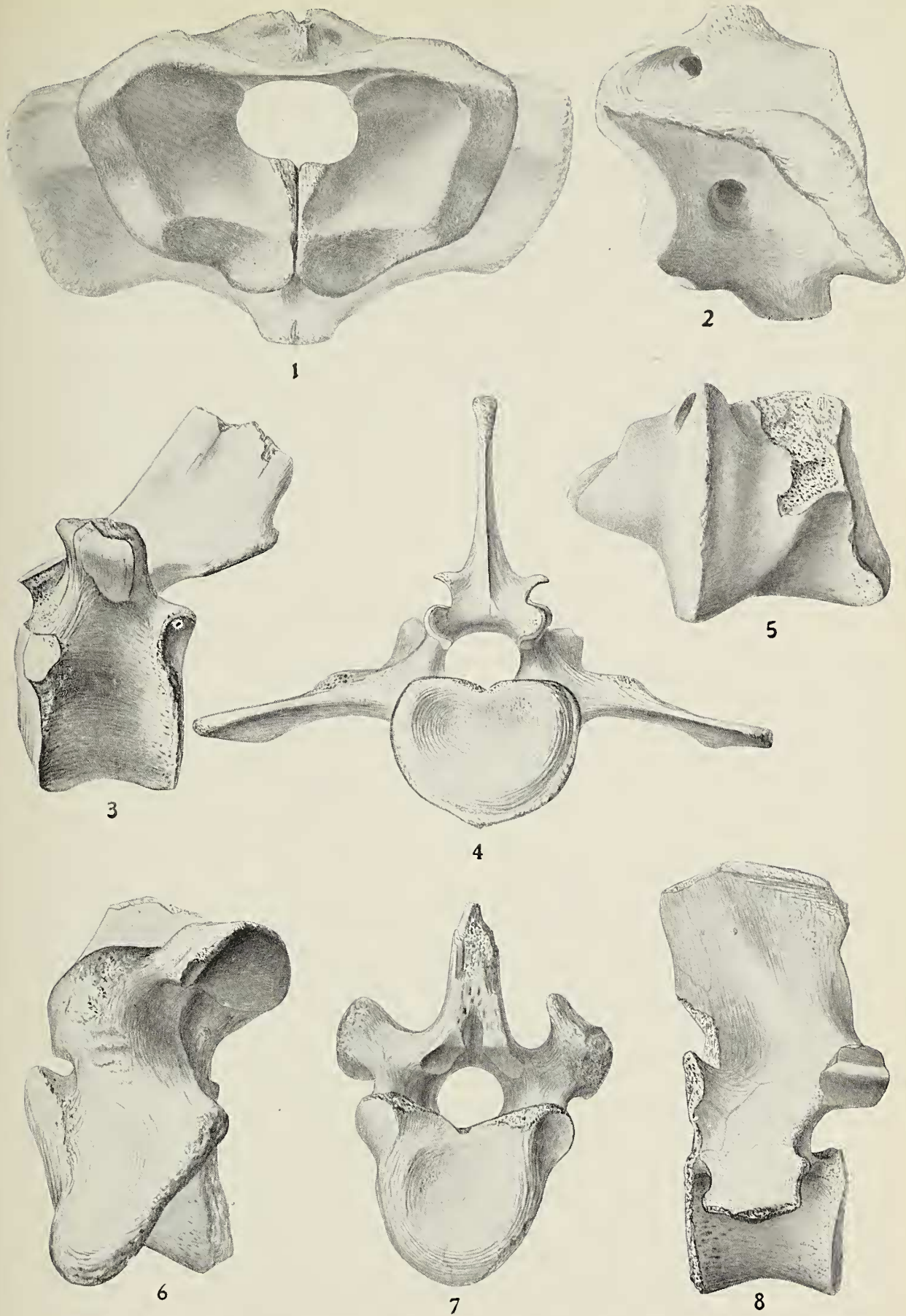


Boötherium bombifrons (Harlan). One-third nat. size.

EXPLANATION OF PLATE XX.

Boötherium bombifrons (Harlan), No. 11,036.

- FIG. 1. Anterior view of atlas.
 - FIG. 2. Lateral view of atlas.
 - FIG. 3. Lateral view of dorsal from the middle of the dorsal region.
 - FIG. 4. Posterior view of lumbar vertebra.
 - FIG. 5. Lateral view of axis.
 - FIG. 6. Lateral view of third cervical vertebra.
 - FIG. 7. Posterior view of dorsal, from posterior region.
 - FIG. 8. Lateral view of lumbar; same bone as fig. 4.
- (All figures one-third natural size.)

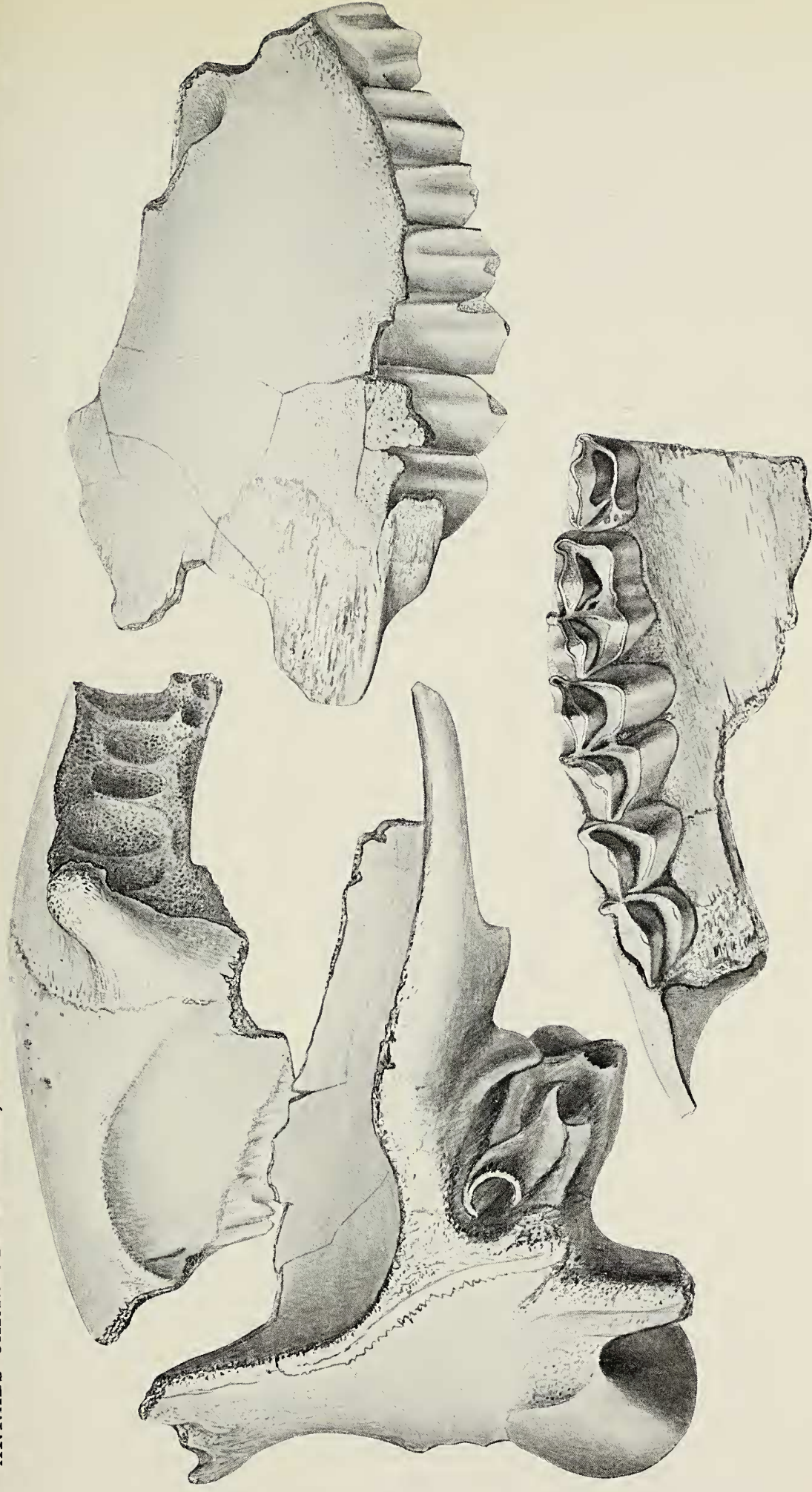


Boötherium bombifrons (Harlan). One-third nat. size.

EXPLANATION OF PLATE XXI.

Boötherium (?) *bombifrons* (Harlan).

Disarticulated parts of skull of young animal, No. 11,036b.
(Two-thirds natural size.)

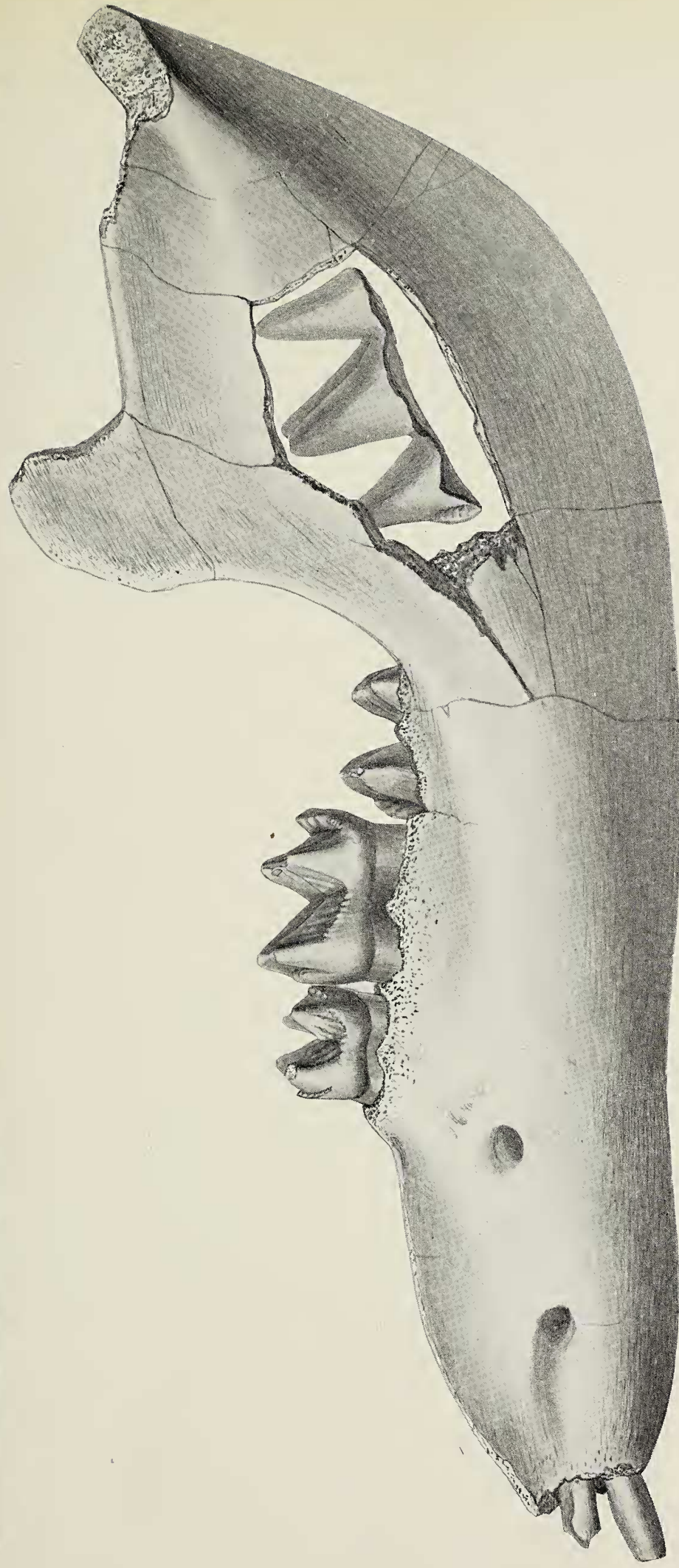


Boötherium? bombifrons (Harlan) juv. two-thirds nat. size.

EXPLANATION OF PLATE XXII.

Mastodon americanus (Kerr).

External face of lower jaw and dentition of young animal, No. 2332.
(One-half natural size.)



Left side of mandible of very young *Mastodon americanus* (Kerr).

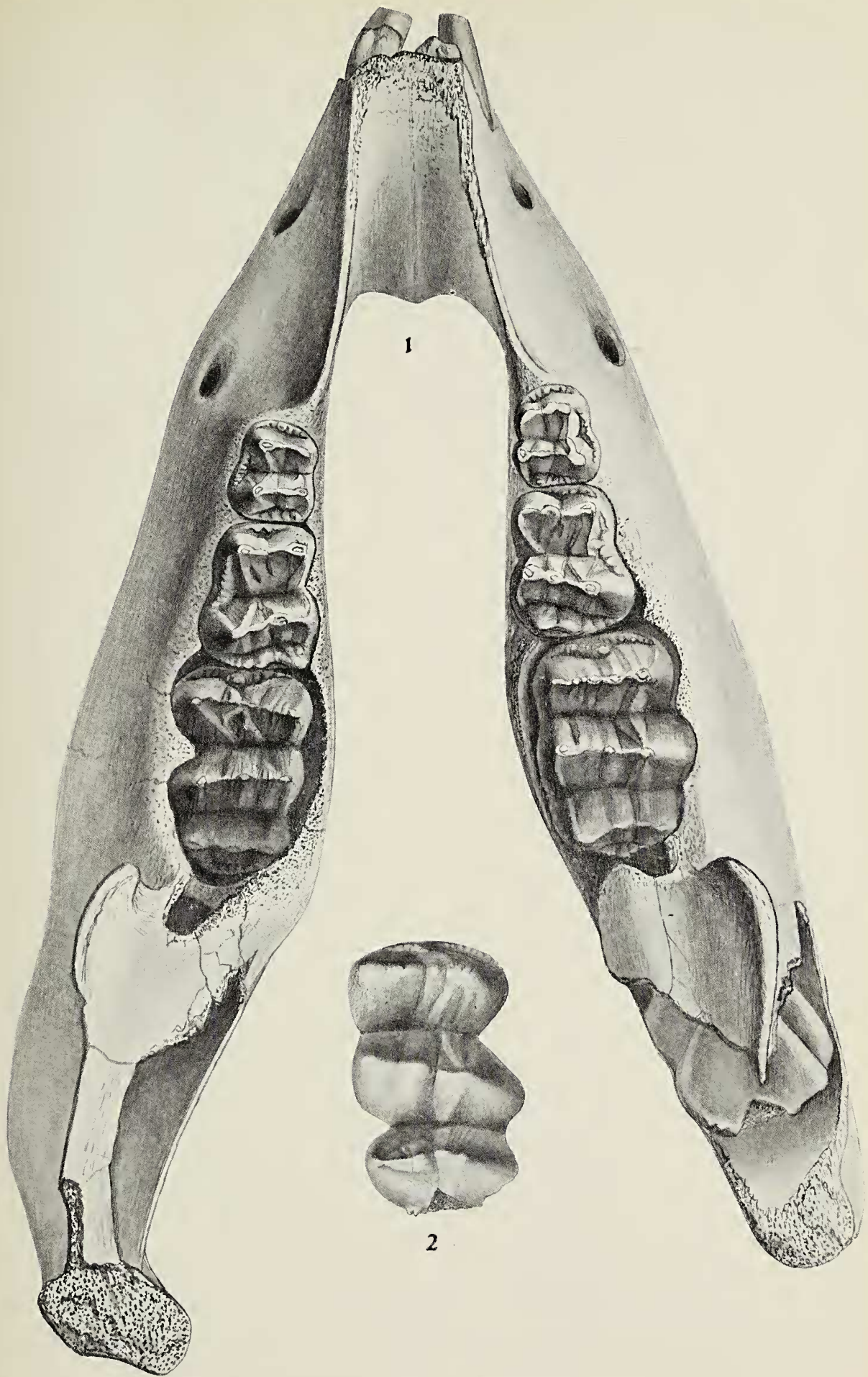
C. M. Cat. Vert. Foss. No. 2332, One-half nat. size.

EXPLANATION OF PLATE XXIII.

Mastodon americanus (Kerr).

FIG. 1. Alveolar face of lower jaw and grinding face of dentition of young animal, No. 2332.

FIG. 2. Grinding face of unerupted molar of right side of same individual as fig. 1.
(One-half natural size.)



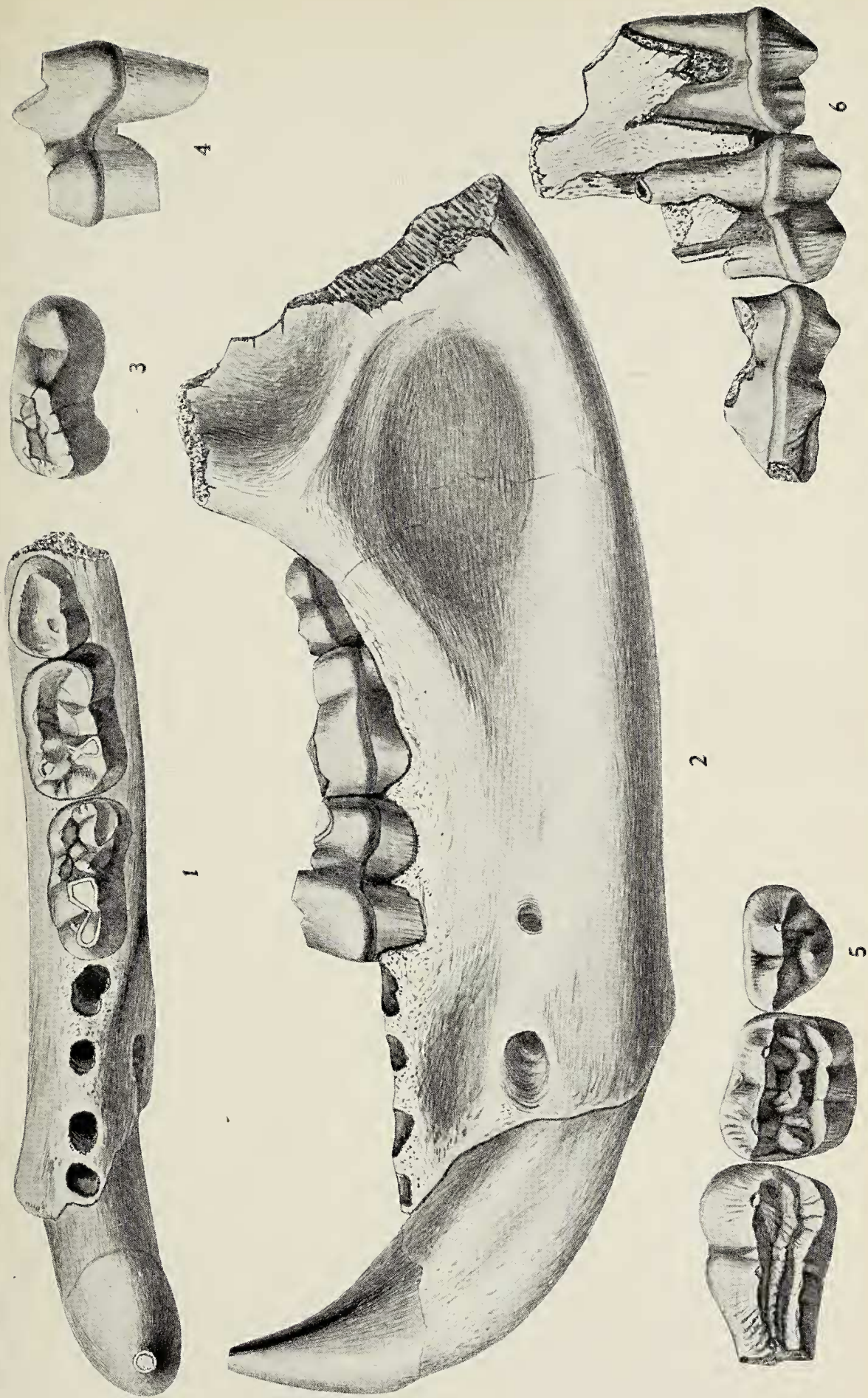
Mastodon americanus (Kerr). One-half nat. size.

EXPLANATION OF PLATE XXIV.

Arctotherium haplodon Cope. .

- FIG. 1. Lower jaw; view of alveolar border, No. 11,020a.
FIG. 2. Lower jaw; view of external face, No. 11,020a.
FIG. 3. Upper first molar of left side; view of grinding face, No. 11,020.
FIG. 4. Upper first molar of left side, external face, No. 11,020.
FIG. 5. Upper fourth premolar; upper first and second molars; view of grinding faces, No. 11,020.
FIG. 6. Fragment of maxillary with upper fourth premolar and upper first and second molars, No. 11,020.

(All figures two-thirds natural size.)



Arctotherium haplodon Cope. Two-thirds nat. size.

EXPLANATION OF PLATE XXV.

Arctotherium haplodon Cope.

- FIG. 1. Radius and pes; view from front, No. 11,019.
FIG. 2. View of ulnar side of right ulna, No. 11,019.
FIG. 3. Scapula, right side; view of external face, No. 11,020.
FIG. 4. Ulna, left side; view of ulnar side, No. 11,020.
FIG. 5. Metacarpals III and IV; view of dorsal face, No. 11,020.
FIG. 6. Lumbar vertebra; view of posterior face, No. 11,020.
FIG. 7. Distal end of humerus; view of anterior face, No. 11,020.
FIG. 8. Axis; view of lateral face, No. 11,020.
FIG. 9. Dorsal vertebra; view of anterior face, No. 11,020.
(All figures approximately one-fourth natural size.)



Arctotherium haplodon Cope. One-fourth nat. size.